Health Promotion and Chronic Disease Prevention in Canada

Research, Policy and Practice

Volume 37 · Number 10 · October 2017

Special Issue: The Food Environment in Canada, Part II

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ISSN 2368-738X
Pub. 160268
Journal_HPCDP-Revue_PSPMC@phac-aspc.gc.ca

Également disponible en français sous le titre : *Promotion de la santé et prévention des maladies chroniques au Canada : Recherche, politiques et pratiques*

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Canada

https://doi.org/10.24095/hpcdp.37.10.01

Commentary

Food environment and vulnerable populations: challenges and opportunities for policy

Lana Vanderlee, PhD, Guest Editor (1); Dana Lee Olstad, PhD, RD (2)

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The goal of food environment policy is to improve dietary intake at a population level, and to thereby improve overall population health. However, the potential for differential impacts of food environment policies and interventions among different segments of the population has seldom been explored.

Socioeconomic position shapes individuals' exposures and vulnerability to both positive and adverse environmental conditions. Given the importance of the food environment in shaping dietary intake, and the role of diet in health, it is therefore possible that health inequities may be at least partially attributable to greater exposures to, and/or heightened vulnerability to the effects of unhealthy food environments among socioeconomically disadvantaged groups. A better understanding of differential exposures and vulnerability to unhealthy food environments among low-income or otherwise vulnerable populations can inform interventions that assist disadvantaged groups to attain their full health potential. This October special issue weaves together five articles that address aspects of health and social inequity from a food environment perspective, with an overall goal of understanding how matters related to food environments, policy and health equity intersect.

Two articles in this special issue describe challenges related to food environment policy making, and the need to enact coherent and comprehensive policy that engages with multiple dimensions of food environments to enhance food security.

A novel paper by Burnett and colleagues highlights persistent problems related to the federal government's response to food insecurity in Canada's North.[1] Specifically, data showing that more than half of communities examined did not have a grocery store that competed with the North West Company suggests that limited competition in the food retail sector may be compounding issues related to food insecurity in remote communities. Moreover, responses to a survey among inhabitants of these communities suggested that the poor quality, higher prices and limited availability of healthful perishable foods may drive purchasing of processed, packaged items which have a tendency to be less healthful. In this way, the authors demonstrate that the failure of policy to engage more broadly beyond providing of food subsidies to address drivers of high prices (i.e. limited competition in the retail food sector) and food quality, has important dietary implications for those living in Canada's northern communities.

The article by Speed et al. introduces an additional challenge with respect to policy making related to the need to consider interactions among different policies or policy components to minimize unintended negative consequences.[2] For instance, policies that promote greater consumption of fresh produce may inadvertently compromise food safety due to the potential for microbial contamination. This article breaks down the concerns of a group of stakeholders within food safety and community food security in British Columbia, and importantly, identified a shared goal of increasing the provision of high quality, safe foods to support an overall healthier food environment for those experiencing food insecurity. Thus, while food environment policy should be broad and comprehensive, the challenge is to ensure that policies also consider the dynamic interplay among various dimensions of food environments to maintain coherence and ensure policies do not act at cross-purposes.

The next three articles focus specifically on physical access to healthful food in retail food environments, and provide potential solutions to commonly encountered challenges. Geographic access to food stores providing more healthful food choices is one of the most widely explored aspects of food environments, particularly with respect to disparities in physical food access between high and low income areas. The attention paid to retail environments is warranted, given that this is the point of procurement for the vast majority of food consumed by the general public.[3] A notable challenge, however, remains in distinguishing 'healthier' and 'less healthy' food outlets, and whether it is even worthwhile to pursue policies in this area in light of this challenge.

The article by Minaker et al. uses sales data to examine the impact of a retail intervention in a corner store situated in a low-income neighbourhood in Toronto, a method used less often in retail intervention research.[4] Corner stores tend to have poorer availability of healthy options, making them an important food environment in which to intervene, particularly in neighbourhoods with limited access to traditional, larger grocers.[5] This preliminary study explored trends in corner store sales data before and after an intervention to increase the availability of fresh fruit and vegetables, and identified opportunities

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for retailers to profit from sales of healthier foods. Given that perceived low profitability of healthy items is a major barrier to increasing availability of healthy items, incorporating sales data into research methodologies may help overcome a major hurdle within the food retail sector. It is important to identify positive impacts of providing healthier options on profitability, as this can obviate the need for policy or intervention as food retailers will naturally provide the most profitable options.

Slater and colleagues examine the concept of food deserts, and the accessibility of larger grocery stores with a greater variety of healthy food products for low-income groups living in Winnipeg.[6] The high proportion of low-income households, particularly in the urban core, suggests that many residents may be vulnerable to poor health, which can be exacerbated by limited access to healthier food retailers. The authors used relatively simple means to identify food deserts using routinely available data, in order to facilitate identification of these areas, providing data to inform policy decisions in support of more equitable access to healthy food.

Lastly, the status report from Mahendra and colleagues provides an update on efforts to establish universal indicators for characterizing access to different types of retail outlets in Ontario, with potential for scale up to other provinces or territories and nationally.[7] As policies to improve food environments continue to evolve, these indicators can provide a framework for monitoring their impact, particularly as they relate to nutritionally vulnerable populations.

The articles within this issue contribute to our understanding of the current food environment, how it is experienced by vulnerable populations, and the challenges related to ensuring policies engage with the multiple dimensions of food environments in support of equitable population health impacts. They also identify opportunities through which policy might address some of the underlying drivers of dietary and health inequities. Health inequities are estimated to cost the Canadian health care system $6.2 billion annually,[8] and these articles serve as a reminder of the importance of applying a health equity lens to population-level food environment policies in Canada.

Acknowledgements

Dr. Lana Vanderlee is a Canadian Institutes of Health Research Banting Postdoctoral Fellow.

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https://doi.org/10.24095/hpcdp.37.10.02

"Highly processed, highly packaged, very unhealthy. But they are low risk": exploring intersections between community food security and food safety

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Abstract

Introduction: Food insecurity and foodborne disease are important issues in Canada, and the public health actions taken to address them can be conceptualized as factors shaping the food environment. Given emerging evidence that these two areas may interrelate, the objective of this study was to explore ways in which community food security efforts and food safety practices (and the population health issues they aim to address) may intersect in British Columbia, Canada, and interpret what this might mean for conceptualizing and attaining healthier food environments.

Methods: We conducted 14 key informant interviews with practitioners working in community food security and food safety in British Columbia, and used qualitative descriptive analysis to identify examples of intersections between the sectors.

Results: Participants identified four key ways that the two sectors intersect. They identified (1) how their daily practices to promote safe or healthy food could be helped or hindered by the activities of the other sector; (2) that historically disjointed policies that do not consider multiple health outcomes related to food may complicate the interrelationship; (3) that the relationship of these sectors is also affected by the fact that specific types of food products, such as fresh produce, can be considered both risky and beneficial; and (4) that both sectors are working towards the same goal of improved population health, albeit viewing it through slightly different lenses.

Conclusion: Food security and food safety connect in several ways, with implications for characterizing and improving Canadian food environments. Collaboration across separated public health areas related to food is needed when designing new programs or policies aimed at changing the way Canadians eat.

Keywords: food security, food safety, public health practice, policy

Highlights

- Efforts to promote food security and healthy eating can counter efforts to ensure safe food, and vice versa, although both have the same goal of improved population health.
- Historically disjointed policies (e.g. food premises regulations that focus on food safety, Canada's Food Guide that focuses on nutrition), and foods that are both risky and beneficial (e.g. produce) create challenges to enacting population health improvements.
- Actions designed to increase fresh food access, or limit foods of high microbial risk, should be developed collaboratively to mitigate unintended consequences.
- Public health activities related to food and health intersect in unexpected ways; collaboration across these separate public health domains is needed when designing programs or policies aimed at changing the way Canadians eat.

Introduction

Food environments have been defined as "the physical, social, economic, cultural, and political factors that impact the accessibility, availability, and adequacy of food within a community or region."[1] Under this definition, actions taken by public health practitioners that alter food availability and accessibility can thus be conceptualized as forces influencing food environments. Additionally, the food–health outcomes that the field of public health aims to address can be conceptualized as factors that drive public health actions. This study explored two domains of public health action related to food—community food security and food safety—and the population health issues they aim to address (i.e. food insecurity, including access to healthy foods, and foodborne disease). Because these domains have historically been considered separately by public health organizations, policy makers and researchers, this study aimed to explore ways in which they might intersect, both within public health practice and through the lens of their influence on food environments.

Food security activities are those that aim to ensure that "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."[2] Included within this definition are efforts aimed at improving community food security such as coupon programs and farm-to-school

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initiatives designed to increase public access to fresh and healthy food.[3,4] Food safety activities, which aim to reduce the risk of foodborne disease in the population, include actions such as creating legislation prohibiting unsafe foods (such as the *Safe Food for Canadians Act*[5]), and outbreak investigations and food recalls.[6,7] Despite the historical separation of such activities in public health practice, there is emerging evidence that food insecurity and foodborne disease share upstream determinants; for example, low income is a risk factor for, and climate change can exacerbate, both food insecurity and foodborne disease in the population.[8] There is also evidence that public health actions undertaken to address one of these population health issues can inadvertently and negatively impact the other. For example, community food security programs aimed at improving access to healthy foods, such as the Farmer's Market Coupon Program,[3] increase consumption of fresh produce, which is a leading source of foodborne disease outbreaks.[9,10] Similarly, the 2004 British Columbia (BC) *Meat Inspection Regulation*, designed to improve food safety, decreased meat processing capacities in remote communities, ultimately increasing food insecurity.[11,12]

These observations suggest that a key yet underinvestigated component of characterizing the Canadian food environment is to understand the ways in which different public health actions, undertaken in areas related to food and health, may actually be playing out in unexpected ways. Although actions to increase access to fresh and healthy foods (e.g. healthy corner store interventions) are recognized elements shaping food environments,[13-16] and although formal food safety activities (e.g. licensing, inspection) have recently been noted as policy tools with which to improve food environments,[17] studies that explicitly explore food safety and foodborne disease risk as part of healthy food environments in Canada are lacking. Given this lack, and given the potential for interrelationships between foodborne disease, food insecurity, food safety, and community food security (hereafter, "food security") activities, the objective of this study was to explore ways in which food security efforts (and the food insecurity issues they aim to address) and food safety practices (and the foodborne diseases they aim to address) may intersect, within the province of British Columbia, Canada, from the perspective of the individual public health practitioner. We then interpreted study findings in the context of the Canadian food environments to suggest areas for future attention.

Methods

We conducted key informant interviews with purposefully sampled individuals working in public health in BC, who had either a community food security or food safety focus, and who had experience working with practitioners in the other sector. We considered those with a food security focus to include both food security and healthy eating practitioners working in public health agencies or community organizations with an aim to increase the population's access to healthy food. We considered those with a food safety focus to include practitioners working in public health agencies with an aim to reduce foodborne disease in the population. Interviews were conducted as part of a broader study whose ultimate goal was to identify barriers and facilitators to successful intersectoral collaboration between these two areas. A semistructured interview guide, which explored participants' experiences working with the other sector, was developed, piloted and revised based on feedback regarding the clarity of the questions. We obtained ethics approval from a University of Waterloo Research Ethics Committee (ORE#20375).

Participants were recruited via email, and all provided verbal informed consent at the beginning of their telephone interview. Interviews were conducted from January to February 2015, and were one to two hours in length. Audio of the interviews was recorded and field notes were also taken. Interviews were transcribed, and transcripts were corrected against the audio files according to methodology outlined by Braun and Clarke[18] and anonymized; quotations appear herein with disfluencies removed to improve readability. Participant recruitment continued until no new themes emerged from the interviews, as per Morse et al.[19]

Of the 19 individuals invited to participate, 14 agreed, one declined and four did not respond within the study timeframe. The 14 participants worked in five of the seven BC health authorities, three provincial-level government organizations and two nongovernmental organizations. They had either front-line or management perspectives in the areas of food security ($n = 6$), food safety ($n = 5$) or both ($n = 3$); and were all in mid to late career. Eight were female and six were male.

To maintain the confidentiality of the results, participants are only identified in this article by position and sector. Food safety practitioners were more easily identified by their position than those working in food security; the majority were environmental health officers, and managers and directors of health protection and environmental health departments. In contrast, food security practitioners held more diverse positions, working in the areas of healthy eating promotion and improving access to local foods, and included community nutritionists and public health dietitians (hereafter called collectively "dietitians"), and project leads.

We conducted qualitative descriptive analysis to identify and explore examples of intersections between the two sectors as discussed by the participants.[20] Analysis was managed in ATLAS.ti version 1.0.50 (282) (ATLAS.ti Scientific Software Development GmbH, Berlin, GER). We inductively analyzed the data as per Braun and Clarke.[18] After immersion in the data, examples of intersections were coded and used to develop preliminary themes. We reviewed and revised themes iteratively, and then further explored each theme using the specific settings and instances described by participants. We used memos throughout the coding process to revisit questions and reflections regarding the data, as per Birks et al.[21]

Results

Through their discussions, participants revealed four important ways in which food security and food safety intersect within the BC public health context. They described (1) how their daily practices to promote safe or healthy food could be helped or hindered by the activities of the other sector; (2) that historically disjointed policies that do not consider multiple health outcomes related to food may complicate the interrelationship; (3) that the relationship of these sectors is also affected by the fact that specific types of food products, such as fresh produce, can be considered both risky and beneficial; and (4) that both sectors are working towards the same goal of improved population health, albeit viewing it through slightly different lenses.

The intersection of specific public health practices

Participants described many ways their own public health activities influenced, or were influenced by, the public health efforts of the other sector (Table 1), including how this intersection posed a barrier to achieving their particular public health goals. For example, food security practitioners experienced a conflict when providing traditional, Indigenous food in facilities licensed to provide or serve food to the public (e.g. daycares, hospitals, dining facilities). As Participant (P) 11 (a dietitian) explained, being able to serve traditional food in public venues is important for food security:

> [F]or First Nations, food security is so much bigger than just having enough food. It's having culturally acceptable food. It's being able to access and have rights to the lands and waters to source those foods, so, being able to serve them at a conference facility, it's health promoting in a much bigger picture, social determinants of health.

However, efforts to provide traditional foods within licensed facilities were often seen as being impeded by food safety activities, as illustrated by P4 (dietitian), who described how the Hazard Analysis Critical Control Points (HACCP) approach to food safety, which aims to ensure the microbial safety of foods by implementing control procedures at important steps during food production, comes into play:

> Well, there is a big issue that arises whenever you're speaking of aboriginal care facilities, whether they're for children, or for seniors, or for people who might be living with disabilities or whatever, and that is that...provision of traditional food is very challenging in those settings, because the settings want to assure safety, and so want to assure that foods have travelled along a HACCP protected path.... But traditional foods don't travel along a HACCP protected path.... So it becomes very challenging, because if you're an aboriginal senior, and all your life you've eaten home canned fish, or fresh caught fish, and you enter a care facility and you want fish, and you get [brand name] frozen fish sticks.... And yet there are no facilities that have that HACCP protected path, so you can say that this has been safe all the way along its journey, from source to plate.

Food safety practitioners experienced a similar conflict in the course of pursing their daily activities in local farmers' markets, a venue in which food security advocates worked to increase access to local, fresh food. As P3 (environmental health officer) explained, when food security efforts went ahead without considering foodborne disease risks, environmental health officers—who have a legal enforcement role to ensure food sold to the public is safe—were then put in a position where they had to react:

> [The population health group] were putting together a list of local food providers.... And what happened is they were charging out there and getting everybody signed up, and getting names and numbers where you can buy, "whatever," and the problem was, "whatever" is what was on the list including uninspected meat.... Once the meat inspection regulations came in, and somebody was cooking perogies for sale, and somebody else was making goat cheese out of uninspected milk, and so, some fairly serious public health issues ... in my mind, and there was no channel for communication, there was just great ideas and they go out and do them, and without any collaboration or even inquiry with us, so when we get wind of it, it's like, "no, you're done, you can't do that." And, of course, the war's on [laughing].

The impact of policies that only consider one food–health outcome

When discussing conflict between food security and food safety efforts, participants spoke about how this was, in part, a product of disjointed policies and regulations that historically have not considered other food–health outcomes in their development and implementation. For example, P12 (dietitian) explained how guidelines, like the food safety guidelines followed within BC's FOODSAFE food handler training program,[22] can cause issues for preschools who serve food to children:

> We've always had an interest, our program, the community nutrition program, in doing more work with the preschool population, and encourage, and promote healthy eating in those areas, those facilities, and what we were finding is that the [food safety] regulations were almost working against us.... On one hand there was licensees, the child care providers were hearing a strong, "you need to be FOODSAFE" message, to the point where, I believe that if it was in a crinkly package, that was good to serve almost, because it was FOODSAFE, and then nutrition was coming along with, "well, we want healthy foods, which are fresh foods," and I think they were somewhat bound with what they could do.

P12 went on to explain that existing food safety regulations often do not consider the impact the regulations could have on healthy eating:

> [E]nvironmental health officers, they're bound by the Food Premises Regulation.... And the actions of the environmental health officers and the licensing officers, as well, and our own documents, weren't as supportive as they could be for healthy eating.... Our food safety requirements for child care providers, for licensed child care facilities, were very strongly orientated to food safety, without the consideration of healthy.

In some instances, the policy disconnect was implicit in participants' statements, for example, in how P13 (food security lead) described Canada's Food Guide as the ultimate guideline in the province, while dismissing the risk of *E. coli* infection (that causes about 33 000 illnesses in Canada each year[23]) and the food safety regulations designed to minimize such risk:

> Basically, Canada's Food Guide is a national guideline.... For healthy eating in Canada, and provincially we use that as a tool, and everybody is implementing working towards healthier food choices.... So, you can't trump that. You can't say, "Kids can't eat salads, because they're dangerous." ... You can't ban hamburger from preschools, right, [laughing]

TABLE 1
Example situations experienced by B.C. public health practitioner participants, in which food security and food safety intersected

Situation	Example quotation
Providing local, fresh, and healthy food in schools	So, with the Environmental Health Officers' perspective, it's very much about—well, their role is food safety—so often the foods that are safe—safer—are often packaged foods, and processed foods, which don't always align with some of the foods that we're trying to promote with schools. [P10, dietitian]
Providing healthy food in child care centres	You can get this list of low risk foods … highly packaged, right, highly processed, highly packaged, very unhealthy. But they are low risk, so—you can really bump up against, say if you're working with a preschool, daycare setting, and you want them to have healthy foods for kids, but you're coming in with the wrong guidelines when you just say, "You can't have those foods." … You've got to say, "You've got to show us how you cook foods properly." [P13, food security lead]
Providing local food in hospitals	There's the discussion about local food provision in hospital kitchens because it's a big buyer of food, and the discussion, "Well, maybe we can get the local meat supplier to supply the meats for the products that they're serving in the hospital, that would be a great market for them to get into," and then you start to think about, "Well, do they really have the infrastructure to be able to support that on a consistent basis, and can they do it safely?" … I think that that's one of the arguments against local provision of food, is that the hospitals need a large volume of very uniform food that doesn't need a lot of processing … safety is another thing, do they have the mechanisms in place, you think a produce supplier, do they have the on-farm food safety aspects, are they following the GAP [Good Agricultural Processes] processes, and do they have that infrastructure in place to be able to produce the reassurance I guess, or the quality of the food, and reassure the users of that that it's of sufficiently high quality that they don't have to worry about a food safety risk when they accept it at the back door of the hospital. [P6, manager, health protection/environmental health]
Providing local food at farmers markets	We weren't happy with hazardous foods at the farmers' market and we wanted some labelling happening on canned goods, and this kind of thing that wasn't part of what [the food security/population health group] were doing. They were just pushing to get some local food out. [P3, environmental health officer]
Promoting community gardens	I mean I would use community gardens right now, they're doing the study out of UBC. You've probably read it, around soil contamination and lead, high lead levels in some Vancouver community garden areas. So, of course that's a huge concern. We don't want people to get lead poisoning, but if we don't have that conversation from the food security perspective, maybe it just gets all shut down and there's no more community gardens in the City of Vancouver, well, that's not good. [P7, manager, food security]
Supporting access to local food and agriculture	… but people just, I guess what it was, "Well, if it was just grown across the street, and it's just a little one-acre farm, then it has to be good for us," attitude, and from the agriculture side, it does sound wonderful, and it could be just awesome, but it could be not, and we just couldn't take that risk, feeding somebody else's children. [P9, food security project lead]
Establishing food safety through local meat regulations	There was a recognition that in some of our more rural remote locations, it wasn't feasible to actually create a provincially licensed abattoir, so they introduced an on-farm slaughter licence, and we have Class D and E licences available in those rural remote locations, and we also have Class E licences that are available outside of those locations, with the feasibility study, and the reason being because if you can take your animal to an abattoir, we would prefer it, because of the food safety standards that are in the abattoir.… So that was kind of a response, recognizing that we wanted to continue to support local food, but yet we wanted to have standards in place. Because we do, obviously, want to ensure that all British Columbians have access for safe local meat, right. [P8, manager, health protection/environmental health]
Food donations to food banks and through community kitchens	[...] we consider produce quite often now as one of the riskier foods [...] just based on the number of outbreaks that have occurred in the last decade or so, often produce is going to be implicated in outbreaks, and certainly this is one of the food types that you'd want to see in a soup kitchen or food bank – or available for donation, healthier food products obviously than the Kraft Dinner [...] model, so I think that we have to take that into consideration, that there are some handling precautions that need to be taken, and there are some limitations on what can be done safely and what can't be done, so, those have to be considered as well. [P6, manager, health protection/environmental health]
Supporting use of culled game meat	Say with the culled game meat, I mean we were getting requests from these municipalities or regional districts saying, "Hey, we're having all these deers killed, and wouldn't it be nice if we could somehow process and donate the food to the local food bank, or First Nations folks or whoever," and we're like, "Well, yeah, that would be a good idea because it's high quality food, so let's kind of work together and make sure that it's done safely. So that they don't get sick when they eat the food." [P1, food safety expert]
Supporting access to local, healthy food donations through gleaning projects	Community nutrition programs have gleaning projects in the [region name], there's a lot of tree fruits there that are left over at the end of the year, so we've worked with them on providing some food safety tips along the gleaning project side of things. [P6, manager, health protection/environmental health]
Improving the health of new mothers and young children	There's a lot of clinics being held in public health these days, related to breast feeding in new mothers, and there's—we're bringing in other groups in there to talk about food safety with them, to disinfection, to talk about personal hygiene in the home, and especially with a lot of pets, and toys and any of the infections that can occur in the home, how to avoid them, and so it brought infection control in there, it brought the food safety people in there, it brought the food security people in there, it brought the healthy eating people in there, so there's a wide variety. [P5, environmental health officer]

> because they have a risk of *E. coli* ... whatever.

Beyond the regulations and guidelines themselves, some participants discussed how different interpretations of food safety regulations can negatively impact food security and healthy eating, as illustrated by P6 (manager, health protection/environmental health):

> And I think that for a lot of people, yeah, the light bulb comes on, "Oh yeah, this makes sense, it's not really that big a deal, let them just go at it," and then there's other people saying, "Well, no, it doesn't meet the letter of the law," so, for some staff, it really depends on their own personal perspective as to how they read the legislation and how much they feel they have that discretion to work around the letter of the law, to do what probably is the right thing to do.

Participants also described how reinterpreting existing regulations can help mutually support both food safety and food security goals. For example, P12 (dietitian) pointed out that the 2007 *Child Care Licensing Regulation*[34] actually supports both food security and food safety in child care centres:

> Where I think we got some buy in, as well, through the health protection—was that doing those food activities with children would actually meet some of the *Child Care Licensing Regulation* statements or requirements. Because we looked at the *Child Care Licensing Regulation*, it states—where is it?—"a licensee must establish a program to instruct and practice the rules of health and hygiene." That's actually Section 46 ... [laughing] ... of the *Child Care Licensing Regulation*. So, we argued that providing food exploration and preparation experiences are ideal hands-on opportunities to teach children about hygiene, health, food safety and hand washing. So, that was one argument, and then, also, there's a whole Section 48, *Nutrition and Child Care Licensing Regulation*, that states that a child— "that a licensee must ensure that each child has healthy food and drink according to Canada Food Guide," and a whole bunch of stuff, right, and then we argued that best practice is to expose children to a variety of healthy foods and food experiences, that are fresh and minimally processed, and that child care providers, that they were confined to prepackaged foods to avoid the approval process. They were going to be compromising nutritional quality. Nutritional quality was a big piece of the *Child Care Licensing Regulation*, so, yeah, for those two reasons, in the *Child Care Licensing Regulation*, we kind of flipped it around and said, "These changes actually help you meet regulations."

P6 (manager, health protection/environmental health) also spoke to reinterpretation, when discussing guidelines that had been developed to interpret food safety legislation in a way that also supports specific food security and healthy eating initiatives:

> And I think that, really what I see in a lot of these food security initiatives is that the staff kind of need the permission to go ahead and consider these things, so there's a couple things that come to mind, is that, yeah, they want to know that they're not going to get in trouble for approving something that they maybe shouldn't have approved if they were following the letter of the law, but also that there's some consistency in that if you're giving somebody an opportunity to do something like this, you may be perceived as being a bit soft in the legislation, but if there's a guideline to support it, or if there's some other documentation that says, if some precedent was set, "Yeah, you can allow this and this and this in this type of facility," then that, kind of, gives them that permission to go ahead and allow that softening of that hard interpretation of the legislation.

The impact of the food product: what's healthy isn't always safe, and what's safe isn't always healthy

Much of the conflict that participants described at the practical and policy levels was related to the fact that the risk of foodborne disease can be higher with the types of fresh and healthy foods that food security efforts aim to promote, and that foods with a low food safety risk are often prepackaged and processed, and thus less healthy and nutritious. Participants predominantly talked about fresh fruits and vegetables versus prepackaged and processed foods or foods that are "in a crinkly package" (P12, dietitian). For example, P6 (manager, health protection/environmental health) compared produce to Kraft Dinner when discussing food donations to places such as food banks, describing the risks of these two types of foods:

> We consider produce quite often now as one of the riskier foods ... just based on the number of outbreaks that have occurred in the last decade or so, often produce is going to be implicated in outbreaks, and certainly this is one of the food types that you'd want to see in a soup kitchen or food bank—or available for donation, healthier food products obviously than the Kraft Dinner ... model, so I think that we have to take that into consideration, that there are some handling precautions that need to be taken, and there are some limitations on what can be done safely and what can't be done, so, those have to be considered as well.

Likewise, P10 (dietitian) illustrated that foods that minimize foodborne disease risk are often not considered healthy:

> [L]ooking at this one document that used to be in place—well, I think it might still be, because this initiative isn't finalized yet—of this list of, "These are the safe foods that you can do in school." I think we actually might still have a Health Link BC document on FOODSAFE that says "Oh, baked goods, high in sugar, or something like that, are safer than doing something like vegetables."

While the idea of fresh produce versus prepackaged foods predominated, other specific types of foods were mentioned in the context of the intersection between food safety and food security. For example, P6 (manager, health protection/environmental health) described how foods that are potentially hazardous from a food safety perspective, such as meat, dairy

and eggs, are also some of the more nutritious foods:

> Unfortunately, the legislation really doesn't speak to any one specific type of food, it talks about potentially hazardous foods a little bit, so that has historically been a bit of a cutoff, and unfortunately, a lot of potentially hazardous foods are also some of the more nutritious foods as well, so ... you've got dairy products, and when you've got some meat products, and eggs, and things like that, there's a higher level of risk generally associated with them, but that's if there's improper handling along the way.

Similarly, P11 (dietitian) discussed how foods that are beneficial from a food security perspective, such as community-prepared traditional foods, may be risky from a foodborne disease perspective:

> [F]rom a First Nations perspective... our environment really has changed, and there's a lot more potential for foodborne illness than there ever was before, and our methods are changing a bit as well, which increases that potential for foodborne illness, when you think of fish or wild game, some people like to—well fish in particular, people have taken to canning, or jarring fish.... And, it's super common in First Nations communities to do that with the boiling water bath, which is not the food safe standard for processing. The standard is pressure canning, and the reason is the temperature that you can bring it to ... you want it to kill potential spores, right, the risk is actually death.

In addition to the above examples, one participant (P13, food security lead) did describe a situation in which the food security and food safety goals of reducing health risks aligned within a food product, when discussing the issue of expired infant formulas:

> ... with infant formulas and baby foods, the "best before dates" and I was quite concerned about the rancidity ... in the formulas, and, of course, that can be a food safety discussion, but it's also a very important nutrition discussion, right ... because of the long-chain essential fatty acids, if they're going rancid you're really causing a problem.... That's also a really important nutrition issue. So, rancidity is not just a toxicity piece it's a nutrition component.

The recognition that, for both sectors, "the ultimate goal is the best health possible"

Overall, participants spoke to the importance of thinking broadly about food's link with population health. For example, P6 (manager, health protection/environmental health) explained that when working toward improved health for the population, it is important to look beyond your own sector to recognize the role of other food–health outcomes:

> But I think there is some understanding that there's more to food than just the food safety side of things, there's a lot more to it in terms of the public health benefits, and I think if you look at the determinants of health, and anybody that's done any work in that area clearly sees that food safety is one portion of it, but there's many other portions, and many other aspects of food that will influence a beneficial public health outcome, so, whether it's nutrition, whether it's food security, there's other things that happen with food that we have to be cognizant of.

In addition, as P4 (dietitian) noted, food plays a bigger role in health than just the physical act of food consumption: "And the local people that I work with, that we all work together, and they've heard me expound on [laughing] those types of issues, that food isn't just food, it's culture, and [laughing] it goes beyond satiety."

Despite describing how activities and policies in food security and food safety can be at odds, most participants recognized that both sectors play an important role in improving population health. For example, P1 (food safety expert) noted that both sectors value food safety's health outcome, stating: "In most cases, they want to see the same things that you want to see in terms of, just safe food, I mean, no one wants to go out, and make anybody sick." Likewise, P10 (dietitian) pointed out that one of the goals of food security is to instill long-term healthy habits in the population, and that food safety is often incorporated into this goal: "Well, both in terms of child care and school settings, it's when children are learning eating habits that will hopefully serve as a foundation throughout their life. So we want both healthy and safe food, in those cases." In addition, participants recognized that food safety is often considered an important component of food security, as illustrated by P1 (food safety expert): "The whole idea of food security, you know, good, nutritious food for everybody, or access to it, but good nutritious, safe food ... to me, really it's definitely connected to our very central theme, just as important as the nutrition."

Finally, participants expressed the idea that the ultimate goal of both the food security and food safety sectors is to improve the health of the population, as described by P12 (dietitian) when discussing food in childcare settings:

> The take home message that we're trying to make is like the ultimate goal is the best health possible for children in care. It includes immediate health and safety, as well as lifelong health, and keeping in mind about how the effect of chronic disease, and the percent of population that's going to be affected by chronic disease, due to poor eating habits and lifestyle, versus the immediate food safety risk.... And in trying to balance them, because they're both really important.

Discussion

This study investigated ways in which community food security ("food security") and food safety intersect, in the context of public health practice in BC. Participants revealed ways in which their daily practices, aimed at improving either the population's access to healthy food, or the safety of food consumed by the public, could be helped or hindered by the activities of the other sector, in part due to historically disjointed policies that do not consider multiple health outcomes related to food. Participants also identified how specific types of food products, such as fresh produce, can be both risky and beneficial to the population's health. Despite these tensions, participants recognized that both sectors are working towards the same overall goal of improved population

health, albeit using slightly different lenses, an attitude that allowed participants to collaborate with the other sector despite the difficulties they faced. These findings suggest several considerations for future characterizations of, and actions aimed to improve, food environments in Canada.

First, these findings suggest that, when acting to create healthier food environments, engaging public health practitioners must go beyond involving those with mandates for nutrition, healthy eating and food security to also include those with a mandate for food safety. Although considering food safety when measuring or acting to improve food environments has been previously suggested,[17,25] this study demonstrates how collaboration with food safety practitioners, or the lack thereof, can impact population health efforts aimed at improving community nutrition environments. In this study, participants provided many examples of how the lack of engagement across food-related mandates made it more difficult for them to work toward safe and healthy diets within given communities. Previous work by Martin and Perkins uncovered existing tensions between food safety and food security practitioners from multiple Canadian provinces,[26] suggesting that the findings presented here may be applicable beyond the British Columbia context. Further work to determine how best to support collaborations between practitioners in these areas is warranted.

Beyond the actions of individual public health practitioners, these findings also suggest that provincial and federal policies related to food and health should consider potential impacts and influences on health, beyond their target outcome. This concept has been previously suggested,[8] and this study provides evidence that policy disconnects can result in less effective actions by frontline practitioners, who must navigate and negotiate areas of conflict in the policy and legislative environment when delivering programs. Formal guidelines may facilitate such navigation, particularly when developed collaboratively. For example, BC's 1997 *Food Donor Encouragement Act* (which absolves food donors acting in good faith of liability for negative health consequences from donated food),[27] can act at cross-purposes to conventional food safety standards, creating situations in which public health practitioners may have conflicting goals (e.g. increasing donations of fresh foods versus enforcing food safety standards), particularly around specific foods such as fresh produce and processed foods, as noted by our participants. In 2016, BC set out guidelines, co-developed with food safety and food bank representatives, that better support safe food practices within the realities of organizations that rely on food donations to operate, including their goal of offering nutritious foods to individuals in need, and the elevated vulnerability of specific client subpopulations (e.g. the elderly, children, immunocompromised individuals) to foodborne pathogens.[28]

In this study, participants were able to discuss the legislation, regulations and policies associated with food safety much more clearly than those associated with food security, in part because food safety legislation has long existed in Canada (e.g. Canada's 1920 *Food and Drugs Act*[29]), compared to relatively new food security–related legislation (e.g. BC's *Food Donor Encouragement Act*, 1997;[27] and Bill M 222, currently proposing a BC Local Food Act[30]). That food safety legislation is more established and recognized than food security legislation has the potential to exacerbate conflict between food safety and food security practitioners, for whom legislation can prescribe public health activities. In our study, participants described positive and negative impacts of the BC *Food Safety Act*[31] within their daily practices (mainly pertaining to the enforcement of food safety standards), but other legislation was not as explicitly nor widely noted. In BC, food safety and food security are two of the province's 21 core public health programs, and there is increasing recognition of their interdependence,[32] with access to safe foods noted as an important part of food security. The food safety core program is focussed on reducing harm related to possible microbial and chemical contaminants, and is underpinned by two provincial acts: the *Food Safety Act*[31] and the *Public Health Act*.[33,34] The food security core program, which is focussed on creating a foundation for healthy eating and a stable and sustainable food supply,[35] is also underpinned by the *Food Safety Act* and the *Public Health Act*,[36] as well as the *Food Donor Encouragement Act*.[27,36] The common legislative underpinnings of these core programs suggest that it may not be the legislation itself, but rather its interpretation and application (including via existing policies and established practices that often only consider one food–health outcome), that may lead to tensions in public health practice. Indeed, in this study some participants described how reinterpreting existing regulations can help mutually support both food safety and food security goals. Exploring how existing legislation may be reinterpreted thus is warranted, but is beyond the scope of this paper.

In our study, participants spoke about particular foods that have both health risks and benefits; the predominant examples were processed, packaged foods and fresh produce. Given that produce is an important cause of foodborne illness in Canada,[10] food environment interventions that aim to increase access and availability of produce should proactively work to mitigate the potential for exposure to pathogens. To date, the dynamic microbial ecosystem of food has not been explicitly considered as a facet of healthy food environments, and future integration is needed. To this end, these findings illustrate that, when characterizing food environments, food safety factors should be measured. To date, the studies of Canadian food environments that have considered diet quality and safety have focussed on aspects such as perceived freshness[37] and physical safety related to travelling to food establishments,[38] and have noted issues related to mice soiling foods.[39] Despite evidence from the US that foods, particularly produce, from markets and retail establishments in low-socioeconomic areas can have higher levels of microbial contamination versus those from high-socioeconomic areas,[40-42] such established food safety indicators have not been included in Canadian food environment assessments. One reason noted for this omission is a lack of data;[25] however, given the wealth of ongoing inspection data collected by local and provincial public health organizations (e.g. Vancouver Coastal Health,[43] Region of Waterloo[44]) incorporating food safety measures into food environment characterizations is theoretically feasible and should be actively explored.

Other previous research examining the link between food safety and food security has focussed on assessing the inclusion of food safety within food security initiatives,[45] and the impacts of a particular food safety regulation on population food security,[11,12] as well as exploring risk factors that can be common to both food insecurity and foodborne disease (e.g.

socioeconomic status,[46] climate change[47]). This study furthers past work by identifying multiple scales at which food safety and food security intersect (i.e. food products, public health practices, government policies). It also highlights issues at play across the Canadian food system, namely the historical separation of food safety and food security that has occurred in public health practice, and the relatively greater level of institutionalization of the food safety function of public health versus the food security function. In our sample, food safety practitioners had more clearly defined positions, including the certified position of Environmental Health Officer,[48] whereas food security practitioners' roles were more diverse and often included community nutritionists and public health dietitians. Food safety practitioners were found solely in government and health authority organizations, whereas food security practitioners were also found in community and nongovernmental organizations. This may be important when considering future community-engaged food initiatives, because community organizations may not represent nor advocate for addressing the actual foodborne risks faced by Canadians. For example, at the time of writing, BC had numerous community-based food security networks, with 14 in the Vancouver area alone,[49] but no community-based groups advocating for food safety. Thus, public health activities, such as local food policy development, that bring community voices to the discussion may not fully address food safety issues within planned activities. If this then leads to future food safety risks, to which food safety practitioners must respond in ways that are seen as negative (e.g. closing premises, recalling foods), a potential cycle of disengagement and distrust may occur, as noted by food safety participants in this study. Engaging across sectors early in the development of public health actions may be an important way to decrease such division.

Strengths and limitations

There is a paucity of literature on this topic, and thus key informant interviews allowed for an in-depth exploration of the various ways that the food security and food safety sectors might intersect, as experienced by public health practitioners in BC, revealing several important areas for consideration when characterizing or acting to change food environments. Our work can guide future, more comprehensive assessments of a wider range of practitioners and provinces. The main limitation of this study is that we targeted individuals who had experience working with the other sector; it is possible that their experiences are different from those of others who have either not worked with the other sector, or who have tried but not succeeded. As well, our participants worked in public health, such that the tensions and intersections reported here may not represent those experienced by others working outside the public health domain. Interviews with others involved in improving food safety and food security (e.g. food skills educators, soup kitchen operators) are needed to further uncover tensions and considerations at the intersection of these two areas beyond the realm of public health. Nevertheless, this study uncovered important areas for consideration when conceptualizing how public health activities and policies can act to shape Canadian food environments.

Conclusion

This study highlights how food security and food safety, two important but historically separate public health sectors in Canada, are actually connected in several ways. It also broadly demonstrates that both foodborne disease and food safety activities are important factors impacting healthy Canadian food environments. It behooves practitioners in these areas to work more collaboratively, in particular to mitigate any unintended population health consequences of activities designed to increase access and availability of fresh foods, including produce, or to limit exposure to foods of high microbial risk. Even beyond food security and food safety, these findings suggest the need to consider how various public health actions related to food and health may intersect in unexpected ways to shape the current food environment, highlighting the importance of engaging across units, both within and between public health organizations, when designing new programs or policies aimed at changing the way Canadians eat.

Acknowledgements

The key informant interviews were funded by a contract from the British Columbia Centre for Disease Control (BCCDC), and the authors thank Karen Rideout and Melanie Kurrein (BCCDC) for their support of that work. The views in this paper represent those of the authors, and not the views of the BCCDC. The authors also thank Abra Brynne (BC Food Systems Network) for discussing, and providing input into, the concepts in this paper.

Conflicts of interest

All authors declare no conflicts of interest or competing interests.

Authors' contributions

SM designed the study, KS analyzed the data with involvement of all authors, all authors interpreted the data, KS and SM drafted the paper, and all authors revised and finalized the paper.

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https://doi.org/10.24095/hpcdp.37.10.03

Retail food environments, shopping experiences, First Nations and the provincial Norths

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Abstract

Introduction: This paper looks at the market food environments of First Nations communities located in the provincial Norths by examining the potential retail competition faced by the North West Company (NWC) and by reporting on the grocery shopping experiences of people living in northern Canada.

Methods: We employed two methodological approaches to assess northern retail food environments. First, we mapped food retailers in the North to examine the breadth of retail competition in the provincial Norths, focussing specifically on those communities without year-round road access. Second, we surveyed people living in communities in northern Canada about their retail and shopping experiences.

Results: Fifty-four percent of communities in the provincial Norths and Far North without year-round road access did not have a grocery store that competed with the NWC. The provinces with the highest percentage of northern communities without retail competition were Ontario (87%), Saskatchewan (83%) and Manitoba (72%). Respondents to the survey (n = 92) expressed concern about their shopping experiences in three main areas: the cost of food, food quality and freshness, and availability of specific foods.

Conclusion: There is limited retail competition in the provincial Norths. In Manitoba, Saskatchewan and Ontario, the NWC has no store competition in at least 70% of northern communities. Consumers living in northern Canada find it difficult to afford nutritious foods and would like access to a wider selection of perishable foods in good condition.

Keywords: food environments, retail, food quality, provincial Norths, northern Canada

Highlights

- Communities without access to all-season roads face extremely high rates of food insecurity.
- Northern retail environments are unique and differ from southern and urban locales.
- The North West Company operates within an oligopoly in the provincial Norths.
- Limited retail competition may be a contributing factor to food insecurity in northern Canada.
- The greatest concern northern participants expressed about food purchasing fell within three main areas: the high cost of food, the quality of food available (e.g. whether fresh or expired), and the availability, selection and variety of specific foods (e.g. fresh produce and dairy products).

Introduction

Northern retail environments are unique and differ from southern and urban locales, thereby posing meaningful challenges to food security.[1] Significantly, conflating the provincial Norths and Far North (the Northwest Territories, the Yukon, and Nunavut) fails to capture the unique contexts and challenges that characterize food retailing in these locales. An in-depth examination of the retail environment in the provincial North reveals several things: that the lack of retail competition and choice, as well as extremely long supply chains and their attendant costs, result in exceptionally high food costs and serious concerns about food quality, availability and selection/variety.[2-5] The termination of the federal Food Mail Program (a transportation subsidy applied to select foods and goods) and its replacement by Nutrition North Canada (NNC) (a subsidy for select foods paid directly to retailers) in 2011 brought the high cost of food to light.[6]

Grassroots Indigenous movements and organizations responding to the changes in the subsidy program have brought the extremely high rates of food insecurity in the Canadian North to the attention of the broader Canadian public through social media campaigns and on Facebook pages such as Feeding My Family.[7] Such community responses have been echoed by academics and international organizations. In 2014, for example, the Council of Canadian Academies published *Aboriginal Food Security in Northern Canada: An Assessment of the State of Knowledge*, which reported that food insecurity in northern Canada is a pressing and immediate issue demanding

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urgent attention.[8] This analysis was preceded in 2012 by the report of Olivier De Schutter, then the United Nations' Special Rapporteur on the right to food, on his visit to Canada, which revealed that 60% of on-reserve Indigenous households in northern Manitoba were food insecure, as were 70% of Inuit adults in Nunavut.[9] De Schutter further noted that these rates of food insecurity were six times higher than the national average and "represent[ed] the highest documented food insecurity rate for any aboriginal population in a developed country."[9] While the situation in the Far North is extremely important, discussions of food insecurity have remained focussed on that region (specifically, Nunavut). And while Nunavut (and the NWT and Yukon) needs access to NNC (and to better, more effective programs designed to lower the cost of food and increase access to land- and water-based foods), the focus of this research is on the retail food environments of First Nations communities in the provincial Norths.

The all-encompassing use of the term *northern* has created confusion as to what constitutes the "North." We are concerned about the conflation of the provincial Norths and Far North and the reduction of the experiences of what are two different regions undergoing food crises to one representative experience. Canada's "North" represents 96% of the country's landmass and includes widely disparate geographic and culturally diverse peoples situated within different economic, political and social environments. Notably, the one continuity between these regions is the disproportionate rates of food insecurity among Indigenous peoples living in rural and northern communities, and the presence of corporate oligopolies.

In this article, we focus on the provincial Norths, often referred to as "Canada's forgotten North."[10,p.312] Frequently, the provincial Norths are absent from conversations about the "North," which generally refers to the Far North (Nunavut, Northwest Territories and the Yukon).[11] While the provincial Norths tend to have more in common with the Far North than the urban south, conflating the regions does them a disservice and fails to adequately account for their distinctive features. Such totalized discourse concerning northern Indigenous populations also does the colonial work of homogenizing First Nations and Inuit peoples and removing them from the specific contexts, geographies and histories in which they are situated.

Background

Over the past decade, a growing body of scholarship that examines food insecurity and environments in First Nations and Inuit communities has developed. However, the majority of this literature remains focussed on the Far North and the land- and water-based practices of the Inuit. Discrete studies exist on the provincial Norths, focussing on specific communities but concentrating primarily on measuring rates of food insecurity. For instance, a 2012 study of 14 communities in northern Manitoba found that three out of every four households (75%) were food insecure. The incidence and severity of food insecurity varied, with fly-in communities generally having more severe and higher rates of food insecurity than those with road or train access.[12] Similarly, a 2013 study in Fort Albany First Nation, located along the James Bay coast in present-day northern Ontario, found that 70% of households suffered from food insecurity.[13] Both works note that the retail environments of fly-in First Nations have limited options, and that lack of access to all-weather roads has an enormous impact on food security.[12] The largest and most common retailer in First Nations communities in the provincial Norths is the North West Company (NWC). Also known as the Northern Store, the NWC has a long history in these communities as the former Northern Department of the Hudson's Bay Company (HBC). In 1987, executives of the HBC and private investors purchased the Northern Department and opened the NWC with an increased focus on retail food sales.[14,15]

Within a market environment of restricted retail options, retailers have an enormous opportunity to shape local food environments and peoples' access to foods. Academics such as Teresa Socha and her colleagues noted that community members regarded the profit-driven model adopted by retailers as a significant barrier to affordable food.[3,4] These researchers posed an important question in relation to the high cost of food: that is, "food or profitability?"[3,p.58] Their 2011 study compared the prices of food between grocery retailers in Thunder Bay and a remote First Nation located in northwestern Ontario, arguing that resolving food insecurity in the provincial North was premised on "solving problems related to the food chain, including transportation, food accessibility, and food availability."[3,p.58]

Solutions to food insecurity include increasing Indigenous peoples' access to land- and water-based foods through supporting community food sharing networks, harvester and hunter support programs and community freezers.[4,12,16] In other words, Indigenous food sovereignty is essential to decolonizing local food environments. However, Indigenous food sovereignty has focussed primarily on control over land- and water-based foods, and while this is extremely important, such a focus can obscure the fact that market-based food systems remain prohibitive in terms of costs and negligent regarding food selection and quality. While food sovereignty is imperative in First Nations communities, it does not preclude the need to have equitable market-based foods systems in operation and under local control as well. Indeed, the need to address the existing market-based food system and the oligopolies that have facilitated the current conditions present in most northern communities is urgent. A comprehensive solution is required that includes both land-and-water-based and market-based food systems and that places a critical focus on the profit-producing operations of retailers in the region.

Historical context

Hunger and food insecurity in First Nations communities located in the provincial Norths are not recent phenomena; they have their roots in settler colonialism and the erosion of Indigenous peoples' access to their foodways.[2,8,9] The establishment of reserves failed to draw on the knowledge and preferences of Indigenous peoples who had lived on and managed their territories and resources since time immemorial. Nor were reserves established with consideration for proximity to food, clean water, medicines or suitability for long-term settlement. In direct violation of the treaties, provincial hunting laws criminalized Indigenous hunting practices by making it illegal to hunt certain animals, thereby preventing Indigenous peoples from hunting during specific seasons, and created bag limits (restrictions on the number of animals within a particular species that hunters may kill and keep).[17-20] For example, in the First Nations Food,

Nutrition, and Environment Study, 65% of participants in on-reserve communities in British Columbia reported that government restrictions affected or limited where they could hunt, fish or collect berries. Indeed, government restrictions were identified as the biggest barrier to harvesting activities.[21]

Under Canada's residential school system, hundreds of thousands of Indigenous children were forcibly removed from their families and communities and confined to schools that were designed to assimilate them. These schools had, and continue to have, a profound impact on the intergenerational transmission of the knowledge required to harvest and prepare wild foods.[22] Climate change has also altered animal migration patterns and reduced the ability of people to continue to hunt and fish.[8] Nevertheless, the harvesting, preparation and consumption of traditional foods remains deeply embedded in the familial, cultural and social fabric of communities and is an essential component of both the social and physical well-being of First Nations.[8,22]

After the Second World War, the federal government undertook a series of social welfare and food subsidy programs as well as education initiatives that had the effect of undermining Indigenous foodways and resulted in Indigenous people becoming increasingly reliant on southern market-based food systems. For instance, in the late 1960s, the federal government instituted a transportation subsidy for a select list of foods to be run through Canada Post, called the Food Mail Program. This subsidy existed until April 2011, when it was replaced by Nutrition North Canada. NNC is a retail-based program intended to subsidize the high cost of perishable, nutritious foods in the North. Retailers receive a subsidy on certain foods that are flown into eligible northern communities. The subsidy is applied on two levels (high or low) for perishable and nutritious foods, and is based on destination and weight. Registered retailers receive the subsidy directly and are responsible for passing along the full savings to their customers with little to no oversight. Until 01 October, 2016, in northern Ontario there were 32 fly-in communities and only eight fully eligible communities,[23] although all were desperately in need of the food subsidy.[6]

The program came under serious criticism in the Auditor General's report in 2014[24], which found that community eligibility was not based on need and Indigenous and Northern Affairs Canada had not verified whether the NNC subsidy was passed onto consumers in full. Following the election of the Liberal government in fall of 2015, another 37 communities were made eligible for the NNC subsidy after October 1, 2016; 19 of these new communities are located in northern Ontario.[23] Consultations have recently been conducted with NNC stakeholders to determine how the program might be improved.[25] What the Auditor General's report[24] did not address was the lack of retail competition in many First Nations communities located in the provincial Norths. Many Indigenous on-reserve communities in the provincial Norths are accessible only by plane or sea barge, and briefly by seasonal ice roads. As a result of long transportation routes, the cost of food is prohibitively high, food selection and quality is limited and communities are usually serviced by a single grocery store. One of the major factors contributing to food insecurity in northern First Nations populations is the relative cost of accessing food, whether from increasing dependence on the market (imported) food system or the rising costs of participating in land- and water-based food-harvesting activities.[26]

Objectives

The objective of this research was to examine the retail food environment in northern Canada in two ways: (1) by considering whether the NWC has market competition for grocery retailing in communities without year-round road access; and (2) by inviting people living in semi-remote and remote communities to share their experiences of the retail food environment in the North. It is very challenging to recruit people living in semi-remote and remote communities to participate in surveys and obtain their perspectives on northern issues. While we acknowledge that there are some methodological limitations to the approaches we were able to use, including a small sample size, this paper presents an important contribution to a very scant body of literature on the topic of retail environments in northern Canada.

Methods

We employed two approaches to assess northern retail food environments. The first was designed to determine whether the NWC faces substantive competition in the North, since the NWC is the major grocery retailer across northern Canada. To accomplish this, we initially created a list of all the northern communities in Canada without year-round road access. We then checked these communities to determine whether they had a NWC store, based on the list of stores on the NWC website (http://www.northwest.ca) in December 2016. From this list, we ascertained whether that store faced any retail competition by searching and listing other stores in the same community that had a full-service grocery store. Thus, small, locally owned convenience stores were not counted as competitors to NWC stores.

We included a community in our study if it met any of the following criteria: it was located in the provincial Norths, Yukon, Northwest Territories, Nunavut, Nunavik, or Labrador; it was part of the NNC program; it was included in the article "From Food Mail to Nutrition North Canada: Reconsidering Federal Food Subsidy Programs for Northern Ontario," published in *Canadian Food Studies* in May of 2015;[6] or, finally, it was listed on the NWC website. In northern Ontario, we also included the municipality of Moosonee because it serves as an important entry point for northern First Nations in the Mushkegowuk territories for services (food, general goods and health care) and is only accessible year-round by rail (as all-season roads are not yet operational). Any store that sold food as a general store or grocery store was included in the study. We counted those stores that had more than one operation in the community (i.e. the NWC often operates a grocery store in addition to a gas station or "Quick-Stop"), which are often contained in more than one building, as one store despite the multiple locations and different retail focusses. While further breaking down these smaller categories may offer additional insight into the breadth and scope of the oligopolies operating in northern communities, such an inquiry is not within the scope of this article.

The second approach was to collect data from community members living in northern Canada using an online survey tool that was developed in consultation with

community members and Elders. The Ontario-based Northern Food Sovereignty Advisory Group (FSAG) comprises seven food activists and community members, including one Elder, who live in communities in northern Ontario and have formed an advocacy group engaging with issues of food sovereignty and addressing current relationships of power and inequality through various activities. We worked with the FSAG over the course of two years, and during our discussions it became clear that there were serious concerns around best-before and expiry dates, food quality, food preference and retail practices, as well as a desire for more information about these issues. We drafted a survey to try and address these concerns, using a scale from one to five and comment boxes to encourage participants to further elaborate on those issues about which they felt most strongly. The failure of people to understand best-before dates is a frequent critique offered by retailers, and so, after a lengthy discussion with community members, we chose to use the term "expired foods." "Expired" is the term most commonly used by community members and the perception that "best before" and "expired" are synonymous is relevant when considering what informs people's purchasing decisions (packaged foods that are being sold after the best-before date). The survey went through a revision process of four drafts in consultation with five of the FSAG community members and the Elder.

The survey was launched using the online survey tool FluidSurveys (Fluidware, Ottawa, ON, CAN) on November 12, 2014, and closed December 31, 2014. We invited northern residents in Canada to share their experiences and concerns about food purchasing experiences with local retailers. To promote the survey and encourage northern residents to participate, postcards explaining the study were distributed at the 2014 Food Secure Canada conference and to our community partners to share with their own social networks. Northern media and social media outlets (e.g. the Feeding My Family Facebook group) were widely contacted as well as northern organizations engaged with food security issues and health and well-being concerns more generally. Due to the significant constraints of conducting survey research in remote communities, we were limited to a convenience sample of participants. Incentives were not provided to survey participants.

Results

Store competition

Across Canada, there are 120 NWC stores (or various iterations of the store: North Mart, Northern) located in either the provincial Norths or Far North that do not have year-round road access, and are briefly accessible in the winter by seasonal ice roads or rail. The NWC operates the sole grocery store in 65 of the 120 communities (or 54%). An additional 55 communities have a second full-service grocery store. In other words, the NWC is the only full-service grocery store in 54% of the communities in which it operates in Canada.

This picture is further complicated if we break down the number of NWC stores according to province and territory. Table 1 shows the number of NWC stores that face competition from at least one non-NWC full-service grocery store in each province or territory. Those provinces that have the highest number of NWC stores are Manitoba, Ontario and Saskatchewan, where the company faces almost no competition. Proportionately, NWC stores located in northern First Nations in Ontario face the least competition; 91% of their stores face absolutely no retail competition. Eighty-three percent and 72% of the communities in northern Saskatchewan and Manitoba, respectively, are serviced only by an NWC store.

Retail experiences

The second element of this work was to assess the retail environment through individual experiences and perceptions of the high cost of food; the quality of the food available to purchase (e.g. whether fresh or expired); and availability and selection or variety of specific foods (e.g. fresh produce and dairy products). Of the 113 people who started the survey, we excluded those who only completed the first few questions of the survey (n = 20) and one person who was living in the United States. The following descriptive analyses were conducted using data from the remaining respondents (n = 92).

The majority of people who responded to the survey were women (71.7%); 27.2% of all respondents were aged 35 to 44 years; 25.0% were aged 25 to 34 years, and 21.7% were aged 45 to 54 years. Twenty-one percent of respondents had 5 or more

TABLE 1
North West Company competition[a] by province or territory, Canada, 2016

Province/territory	Number of communities with an NWC[b]	Number of communities with only an NWC		Number of communities with a grocery store in addition to NWC	
Alberta	4	1	25%	3	75%
British Columbia	1	0	0%	1	100%
Manitoba	25	18	72%	7	28%
Newfoundland and Labrador	4	1	25%	3	75%
Northwest Territories	18	13	72%	5	28%
Nunavut	22	1	5%	21	95%
Ontario	22	20	91%	2	9%
Quebec	11	1	9%	10	91%
Saskatchewan	12	10	83%	2	17%
Yukon	1	0	0%	1	100%
Canada	**120**	**65**	**54%**	**55**	**46%**

Abbreviation: NWC, North West Company.

[a] This sample to determine competition with the NWC was limited to the 120 communities without year-round road access that had a NWC store.

[b] This number was determined by counting the NWC stores listed on the http://www.northwest.ca website in December 2016 in communities in each of these provinces/territories that did not have year-round road access and that sold food as a general/grocery store.

people living in their household, with an average of 3.4 people per home. Approximately one-third of our respondents (32.6%) resided in northern Ontario; the next highest number of respondents were from Northwest Territories (21.7%), Manitoba (18.5%) and Nunavut (12.0%). Eight of the provinces and territories were represented (Figure 1).

Eighty-nine percent of respondents identified themselves as currently residing in a remote or semi-remote community. All of the people who did not currently live in a remote or semi-remote community but had lived in one previously were asked to provide their perspective from when they had lived there.

About half (51.1%) of respondents lived in a community with year-round road access. Of the respondents who mentioned the cost of gasoline (n = 74, 80.4%), the average cost was $1.59 per litre and ranged from $1.00 to $3.00 per litre.

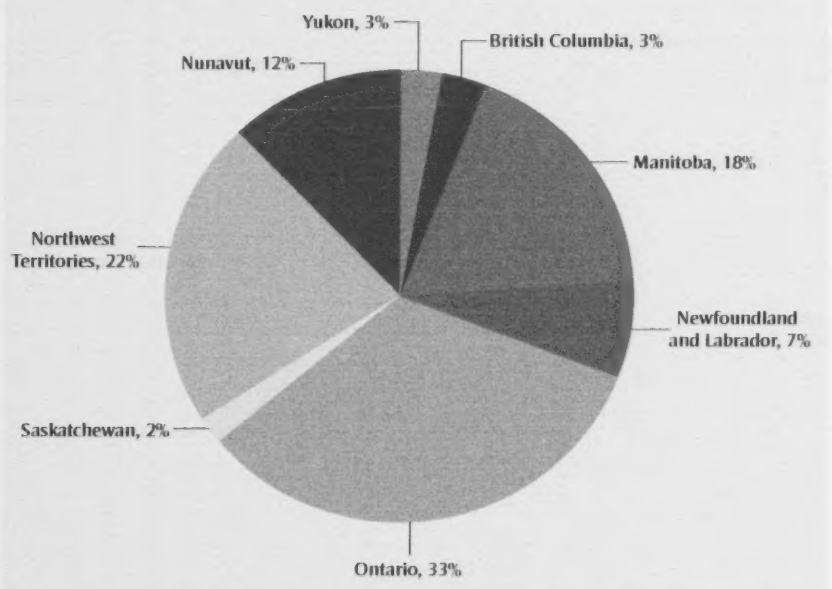
The majority of respondents reported doing most of the food shopping for their household (84.7%). The store that respondents indicated they used most often as their primary retailer was the NWC (49.5%), followed by private, locally owned stores (18.9%), a community-owned store (15.8%) and Arctic Co-operatives (6.3%). When asked, "Does the store sell expired food?" with the response options of "Often," "Sometimes," "Never" or "I don't know," 82% of respondents stated that their store often or sometimes sold expired food. When asked, "Is the perishable food usually in good condition?" with the response options of "Yes" or "No," more than half (57%) of the respondents said perishable food was not usually in good condition. Those respondents who said that perishable food was not usually in good condition were able to provide comments about the condition of this food in their store. Their comments described foods that were not fresh; shopping practices that involved paying great attention to checking food quality prior to purchasing perishables; and difficulties related to food freshness and quality that arose from long transportation routes. ("More often than not, they are close to rotten or rotten when they arrive," wrote a participant from a remote community in northern Manitoba). Some described the food as having variable quality (e.g. a participant from a remote community in Yukon commented "Highly variable—sometimes arrive in good condition, bananas and cucumbers regularly frozen/soggy"). Some reported having to make sure to consume it quickly after purchase (e.g. a participant from a remote community in the Northwest Territories defined her fresh food purchases as "rotten, or so ripe [they] must be consumed immediately," and another participant from a semi-remote community in northern Ontario wrote, "Usually have to use the day you buy it.") Several people described the winter months as a time when perishable food was of poorer quality, while others explained it was an issue all year round ("They don't last longer than a day or two once purchased.... Winter months are worse than summer months," offered one participant from a remote community in Nunavut).

When asked, "What is your biggest concern when shopping at your primary retailer?", the greatest concerns participants expressed regarding food purchasing fell within three main areas: the high cost of food; the quality of the food available to purchase (e.g. whether fresh or expired); and the availability and selection or variety of specific foods (e.g. fresh produce and dairy products). When asked, "What are the top five food items you purchase most often?" the food purchased most often was milk. When participants were asked, "Name the top three fresh or perishable healthy foods that you think should be made more affordable," they chose produce (i.e. fresh fruit and vegetables), followed closely by milk and meat.

At the end of the survey, participants were asked if they had any additional concerns or if there were questions that they had not been asked. Twenty-seven people (29.3%) provided additional comments. Some of the comments included possible reasons for the lack of variety and quality of products available to them, such as this from a member of a remote community in Nunavut:

> The lack of variety comes from the Head Office as the employees are only limited to what they can order in the order guide. Also they have get in a lot of their own brand which is horrible because they make more money on selling their own brand. Also we have notice even the groceries coming in on the barge which

FIGURE 1
Geographic representation and percentage of survey respondents from each province and territory



> should be cheaper because it is barged in, is at the same price as the groceries coming in on the planes. Also all this non food items all seem to be cheap stuff but they sell it at huge prices ... crap we can buy in dollar stores down south but they mark it up so much. Now we know why The North West Company always makes a profit because the prices are out of this world.

Others were very focussed on the high cost of specific staple foods compared to those that were less healthy, such as this from a remote community in northern Manitoba:

> Why isn't the price of milk, eggs, bread, etc the staples of a household not regulated across the country? I have never seen any of the above go on sale. Cost of 4 litres of milk is over $8.50, in the northern town where I live. Yet 2 litres of Pepsi & coke products can go on sale for $1.00, potato chips go on sale. Alcohol is regulated, but milk is not, something has to be done about that.

Comments also provided details about some of the challenges to food access during specific times of the year and how that impacted prices: "During spring break-up and fall freeze up we chopper groceries across. I see food prices go up during this time, but they never go back down" (from a member of a remote community in Northwest Territories). Several respondents also described the cost of food in comparison to the cost of living: "How are you supposed to make a living when milk is 15 dollars? I know that's not even the worst in Canada, but seriously. People have to feed their families and all they can afford is the terrible and unhealthy pre packaged food" (from a remote community in northern Ontario). Finally, a number of respondents questioned the profits made by retailers and referenced government subsidy programs, including the NNC subsidy: "I believe that there needs to be more transparency with how much the food costs, how much the retailer profits, and how much the government is subsidizing the rates by" (from a remote community in the Northwest Territories).

Discussion

In this paper, we highlight the scope of the NWC's food retailing operations in the provincial North, and describe the context of the food retail environment in the Far North and provincial Norths by drawing on the perspectives of people living in those communities. Reducing the experiences and contexts of many different communities and locales within a vast area to one described as simply the "North" does not adequately address the nature of the retail and food environments of northern Indigenous communities. There are significant differences between the Far North and the provincial Norths, as well as within those regions and communities. Our objective was to address and illustrate some of the unique challenges that many First Nations communities in the provincial Norths face in acquiring market-based foods, both in terms of the lack of competition, the existence of oligopolies, and general retail experiences.

Our analysis of retail competition in northern Canada demonstrated that the NWC holds market dominance in the provincial Norths especially when it comes to the sale of food. Between 1987 (when the Northern Department of the Hudson's Bay Company was sold to executives of the Northern Store and private investors) and 2015, the portion of those profits from the sale of food has more than doubled from just over 30% to 79.3%.[27] Indeed, participation in a retail food market has proven so profitable to the NWC that the company expanded in 2007 through the Cost-U-Less initiative to the South Pacific and Caribbean, citing "a leading competitive position that's supported by high barriers to entry."[27] The market dominance of the NWC in the North is facilitated by the company's ability to access government subsidy programs such as Nutrition North Canada and its predecessor, the Food Mail Program. During the 2014/15 fiscal year, the NWC received the majority (50%) of the NNC subsidy from the federal government, while the recipient of the next highest amount was the Arctic Co-operatives, located primarily in Nunavut, Northwest Terroties and Yukon, at only 19%.[28]

The regions that contained the highest number of NWC stores in Canada were northern Manitoba and Ontario (with 25 and 22 stores respectively). Very few of our sample communities contained a second full-service grocery store: in northern Ontario there is one First Nation that has a second full-service grocer, and in Manitoba there are seven. While the challenging retail environment has limited retail competition and precluded the establishment of more than one grocery store in many communities, those retailers that do operate in northern First Nations continue to make a significant profit. A 2014 report on NNC, entitled "Northern Food Retail Data Collection and Analysis," commissioned and released by the federal government said that while "retailers were unwilling to provide specific financial information regarding the profitability of their northern retailing operations," it nonetheless concluded that "northern grocery retailers are making a profit from their activities in northern communities and therefore profit is a factor contributing to the overall cost of groceries."[29]

The online survey we conducted in northern Canada provides texture to the description of the retail environments and brings into sharper focus a number of the issues highlighted in the November 2014 Auditor General's report on NNC,[24] the recently released Government of Canada report about the NNC public community engagement process,[25,30] and an external program evaluation.[31] The government report summarized general observations from community members about the public engagement process as follows:

> Northerners feel that everything in the North is expensive, with a number of participants stating that, as Southerners, it is difficult to understand those struggles, which is then further intensified with many people living off a fixed income. Even with the subsidy provided through NNC, for which they generally expressed an appreciation, many families are not able to afford healthy food. There were significant concerns regarding the overall quality and availability of nutritious perishable food in the North.[30]

Our findings from surveying the experiences of northerners with retail food access generally aligned with these observations. People living in northern and rural First Nations that are accessible briefly by seasonal ice roads demand access to a wider selection of food that is in good condition at affordable prices. The quality of perishable foods poses a

significant concern and often serves as a barrier to the purchase of fresh foods. The fear of spending money on inedible food may prevent people from taking the risk of buying new types of food, or make them decide to purchase ready-made or fast foods that they can be fairly sure they will be able to eat. Indeed, quality consistently remains one of the principal concerns expressed by community members but continues to be considered the least important factor when it comes to research design or assessing the success of the NNC program, both of which to date have focussed on collecting the prices of a select list of foods from the Revised Northern Food Basket (RNFB).* A failure to understand the dynamic between food quality and food purchasing practices in the North adds to the misconception that people in First Nations communities in the provincial Norths choose to purchase unhealthy, prepackaged and processed foods rather than healthier fresh produce and perishable items; in fact, food purchasing decisions are often influenced by past experiences of purchasing rotten, mouldy or less-than-fresh food that is inedible.

Finally, while all community members have questioned the current terrain of the retail environment that exists in fly-in and northern First Nations located in the provincial Norths, there is a real and marked failure on the part of government agencies to pose those same questions. The 2014 Auditor General's report on NNC noted that some communities in northern Ontario were eligible for NNC and others were not. It made no mention, however, of the dominance of the market-based food system by one company and that company's influence on and access to the decision-making processes that affected Indigenous communities. For instance, when consultations on the Food Mail Program were undertaken in 2007 to 2008, the NWC's consultation with Dargo and Associates (the consulting firm) was either on par with that of communities and First Nations or even, in some cases, exceeded the access given to community members.[33] What is more, this report argued that the relationship between the federal government and food retailers "encourages market disruption and is at odds with the Minister's mandate of supporting northern economic development."[33,p.17]

Drawing on data collected by NNC, Galloway[31] studied whether or not the existence of the subsidy program made a meaningful difference in the cost of food in northern communities. She found that the lack of retail competition in small communities, even those subsidized by NNC, resulted in extremely high food costs. She provided examples from the Far North, noting that communities with a second retailer still could not be considered a competitive food retail environment, and those communities with a single food retailer exhibited the highest cost of food in Canada.[31] In our research, we found that there is a shortage of competition for food retailers in the provincial Norths. We suggest that limited retail competition plays a significant role in food insecurity in northern Canada. Further research is required to obtain data on the oligopoly of the retail food environment in northern Canada and to provide more evidence as to whether a lack of retail competition makes food costs considerably higher in these communities.[31] Quantifying the differences in food costs for communities with multiple food retail competitors versus those with oligopolies or monopolies, along with an examination of food quality and further investigation of the perspectives of people living in northern Canada, is warranted.

Strengths and limitations

This paper addresses a relatively unexamined topic in regards to food security in First Nations communities located in the provincial Norths. The paper only examined retail competition in the 120 communities that had NWC stores and did not have year-round road access. The online survey was informed by community members from the FSAG and reflects their concerns about their shopping experiences, and cannot be representative of everyone. The number of survey respondents was limited by several factors: the need for access to the Internet in order to complete the survey, language barriers, and the fact that the most marginal members of the community were unlikely to respond. The result was a small sample size (n = 92) representing eight provinces and territories and not presenting a complete picture of food retail experiences across northern Canada. However, due to the challenging nature of collecting this type of data in remote regions, along with the absence of other data on shopping experiences from residents in northern locales, this study is a first step in building new information on this topic.

Conclusion

Food insecurity in northern Canada, especially among First Nations and Inuit people, is a pressing public health problem. Limited retail food competition have exacerbated this issue enormously. In northern Ontario, there is only one full-service grocery store in 91% (20 of 22) of the fly-in First Nations communities that are only accessible by seasonal ice roads. Limited retail choices also affect the range and quality of foods that people are able to purchase. Efforts to support Indigenous food sovereignty must address all elements of local food economies, including retail and land and water harvesting activities.

Acknowledgements

We would like to acknowledge the kindness, generosity and patience shown to us by the community members who worked with us on this project. We also thank Robert Thivierge, who did the legwork of identifying grocery stores in northern Canada, and James Jung, who helped us with some last-minute fact checking. The research was funded by SSHRC.

Conflicts of interest

The authors do not have an affiliation with or involvement in any organization or entity with any financial interest or non-financial interests in the subject matter or materials discussed in this article.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

Authors' contributions

KB and KS were involved in the conceptualization of the work; distribution of the survey; acquisition, analysis and interpretation of data; and drafting and revising

* The RNFB is a survey tool created by Indigenous and Northern Affairs Canada in consultation with Health Canada to monitor the cost of food in remote northern communities. The RNFB is based on average overall consumption for a sample population and contains 67 items (as revised in 2008) and their purchase sizes.[32]

the manuscript. TH was involved in the distribution of the survey; analysis of the data and drafting the manuscript. JL was involved in the conceptualization of the work and the drafting of the online survey and its distribution among community members. LC was involved in the conceptualization of the work and revising the manuscript.

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Exploring sales data during a healthy corner store intervention in Toronto: the Food Retail Environments Shaping Health (FRESH) project

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Abstract

Introduction: Population health interventions in the retail food environment, such as corner store interventions, aim to influence the kind of cues consumers receive so that they are more often directed toward healthier options. Research that addresses financial aspects of retail interventions, particularly using outcome measures such as store sales that are central to retail decision making, is limited. This study explored store sales over time and across product categories during a healthy corner store intervention in a low-income neighbourhood in Toronto, Ontario.

Methods: Sales data (from August 2014 to April 2015) were aggregated by product category and by day. We used Microsoft Excel pivot tables to summarize and visually present sales data. We conducted *t*-tests to examine differences in product category sales by "peak" versus "nonpeak" sales days.

Results: Overall store sales peaked on the days at the end of each month, aligned with the issuing of social assistance payments. Revenue spikes on peak sales days were driven predominantly by transit pass sales. On peak sales days, mean sales of nonnutritious snacks and cigarettes were marginally higher than on other days of the month. Finally, creative strategies to increase sales of fresh vegetables and fruits seemed to substantially increase revenue from these product categories.

Conclusion: Store sales data is an important store-level metric of food environment intervention success. Furthermore, data-driven decision making by retailers can be important for tailoring interventions. Future interventions and research should consider partnerships and additional success metrics for retail food environment interventions in diverse Canadian contexts.

Keywords: retail food environment, population health intervention, sales data, convenience stores

Highlights

- Public health practitioners interested in retail food environment interventions can use sales data to inform comprehensive evaluations.
- Sales data can be used to tailor healthy corner store interventions to the local context (for example, special promotions on peak sales days).
- Using sales data is important for research and also for store owners, who can use sales data metrics to inform their own business practices.

Introduction

Retail food environment interventions in stores (e.g. grocery store and corner store interventions) are increasingly recognized as important public health interventions to improve the nutritional quality of food purchases.[1-4] Such interventions aim to support healthier dietary behaviours by improving access to and availability of affordable, nutritious food options in the community and consumer nutrition environments.[5,6] Food stores are especially important sites for healthy eating interventions, since over 70 cents of every household food dollar is spent in stores (as opposed to restaurants).[7]

Food sales data have been proposed as valuable, objective, cost-efficient and unobtrusive measures of diet-related behaviour that place no burden on individual participants.[8] Store sales data (e.g. directly collected checkout scanner data, commercially available data sets and grocery receipts) have been used to monitor the effectiveness of interventions in a variety of types of retail food stores,[9-12] including a number of recent small-store studies.[13-17] Together, these studies suggest that sales data can actually be used in the design of retail food interventions. For example, Foster and colleagues[9] found that low-cost strategies focussed on improving product availability and placement enhanced sales of some foods and beverage categories (milk, water, frozen meals) but not others (regular soda, diet soda, cereal).

A recent systematic review of the effectiveness of supermarket interventions aimed at improving the healthiness of consumer purchases found that of 49 relevant studies identified, none reported on the economic or financial effects of the

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intervention on the retailer.[4] A 2012 narrative review of grocery marketing strategies aimed at improving diet found that only 5 of 125 reviewed studies used sales data to evaluate impacts of diverse strategies.[3] Another 2012 review that examined impacts of retail interventions in small food stores found the majority of studies (11 of 16 evaluations) did not analyze sales data.[2] Only a few studies have used sales data to assess retail performance of the store as the primary outcome of interest.[18] There are many reasons why previous research has not used sales data, including the potentially sensitive nature of the data, and its poor quality due to human error or technological barriers. However, the lack of published sales outcomes remains a significant gap in this body of research, because even if well-designed retail food environment interventions can successfully improve dietary behaviours in the population, the population-level impact will not be sustained unless the intervention's effects align with retailers' economic goals.

Given the importance of economic data to decision making in retail settings, treating sales data as an important metric in retail food environment intervention evaluation is crucial for both implementation and intervention sustainability.[4] Within the retail sector, smaller stores have reduced capacity to engage in data-driven decision making. Evaluating sales may increase the potential to promote healthy retailing interventions among a diversity of food retailers,[19] especially given store owner concerns about potential revenue loss.[20,21] Indeed, lack of sales data from previous studies may act as a barrier to other stores adopting healthy food interventions. In addition to retailers, this type of information is also important for legislators who are considering how to craft policies to support healthy food environments in Canadian jurisdictions.[22]

The objective of the current study was to characterize store sales over time over the course of a healthy food retailing intervention in a low-income, urban neighbourhood. We examined food and beverage sales, as well as sales in several nonfood product categories. We present nonfood product category sales in this article to provide context in terms of potential risks and opportunities small retailers face when they implement a healthy food retail intervention.

Methods

The Food Retail Environments Shaping Health (FRESH) study was funded by the Public Health Agency of Canada, led by Toronto Food Strategy (an initiative of Toronto Public Health) and collected data from August 2014 to April 2015. The FRESH study used mixed methods to assess individual-level dietary and food security impacts of a pilot healthy corner store intervention and a mobile good food market intervention (a retrofitted city bus that distributed and sold fresh vegetables and fruits to neighbourhoods with low grocery store access) in two low-income neighbourhoods in Toronto, Ontario. This article reports on sales data from the corner store that participated in the healthy corner store intervention. Unfortunately, sales data from the mobile good food market were of poor quality and therefore unreportable.

Setting

The neighbourhood in which the intervention corner store was situated was in Scarborough East – Ward 43 in Toronto, Ontario, a ward in which 42% of residents live in apartment buildings with more than five stories, 52% of residents were born outside of Canada, 57% of residents speak English as a first language and average annual household income is roughly $20 000 less than the Toronto average.[23,24] The intervention corner store was situated in the heart of Scarborough East, on the main floor of an apartment tower complex. The site was identified by Toronto Food Strategy in partnership with East Scarborough Storefront, a community organization aiming to support people and build community in Scarborough East. We approached storeowners to participate, and they became active participants in all intervention decisions and in sales data collection. Unpublished data from the broader FRESH study (which included surveys with n = 199 residents who were primary food shoppers and lived in the intervention apartment tower) showed that among residents of the apartment tower complex in which the store was located, 83.3% were born outside Canada, 69% had at least one child and 78% had annual household incomes below $30 000.

Intervention

The transformation of the convenience store pilot site was an iterative process encompassing (1) business fundamentals, including food procurement, infrastructure and sales analytics; (2) customer service and engagement; and (3) various merchandising strategies. Key goals of the intervention were to improve supplier relationships and merchandising to increase availability and prominence of nutritious foods and beverages. In this intervention, "nutritious foods and beverages" were considered those that aligned with Canada's Food Guide recommendations. In collaboration with public health dietitians from Toronto Public Health and with the store owners, we identified specific nutritious foods and beverages to be sold (e.g. fresh whole fruits and vegetables, water, popcorn, low-sugar granola bars, snack packs of vegetables). We introduced and promoted nutritious foods over the course of the intervention. Nutritious items were priced competitively with comparable products at the nearby discount supermarket (approximately 1 km away). The initial recruitment of the corner store took place in December 2013; the infrastructure changes to support the sale of fresh produce, such as purchasing and installing new refrigeration units and changes to existing shelving, happened between June 2014 and February 2015; and fresh produce began to be offered for sale in June 2014.

To increase the store's year-round fresh fruit and vegetable supply, Toronto Food Strategy connected store owners with a Toronto-based fruit and vegetable distributor. Toronto Food Strategy helped store owners open an account, and trained them in the ordering process. The store owners also procured fruits and vegetables from a nearby local Asian supermarket. Members of the research team visited the store between one and three times per week throughout the intervention to provide ongoing support, including training on sales data collection through the point-of-sale (POS) system (described below).

Of relevance to this study was the fact that the apartment tower's residential landlord company had its own ongoing free snack program available every school day to all children living in the apartment tower. Every week, the landlords purchased fresh produce for the snack program from a nearby warehouse-style club store to distribute to school children. In November 2014, the store owners successfully negotiated with the landlords to

begin supplying the fresh produce for the snack program at the same price.

Several challenges to consistent implementation emerged throughout the intervention, including making improvements to general business operations, engaging store owners in considering data quality, building capacity in data-driven retail decision making, creating merchandising strategies, establishing links with the community, and negotiating complex relationships between the store owners and regular customers. These challenges are consistent with those observed in other healthy corner store intervention contexts.[20]

Measures

We collected sales data through a POS system. The POS system was installed in January 2014, and tracked the date and time of sale, UPC code, researcher-programmed product category (e.g. sweetened beverage, bottled water, candy, fruit, vegetable, lottery tickets, cigarettes, etc.), quantity purchased and item price. A company that specializes in digital marketing inside convenience stores supported the project by providing the POS equipment, installation, maintenance and training at no cost. The company tracks advertising effectiveness in the corner stores with which they work, and agreed to advertise only nutritious foods and beverages throughout the project. The research team was able to request updated sales data on a regular basis from the POS provider throughout the project. Although the POS system was installed in January 2014, it took several months for reliable data to become available, and to build practical capacity in data management and use of the POS system on the part of the store owners. Data presented here therefore have been restricted to the consistently higher quality data obtained from August 2014 to April 2015, the last month for which data were available. In addition, we restricted our analyses to revenue (overall store sales generated by retail items) rather than profits (revenue less expenses), since comprehensive data on expenses were not collected.

Analysis

We aggregated sales data by product category and by day to examine store sales over time. We used pivot tables to organize and summarize data in Microsoft Excel. We also created visual representations of sales data using graphing features in Microsoft Excel.

First, we summarized total store sales by day and plotted the data on a graph over time to visually inspect the consistency of store sales over time. Preliminary findings suggested that store sales appeared to spike on certain days of the month, which we refer to as "peak" sales days throughout the remainder of this paper. Further investigation revealed that peak sales days consistently occurred the day after social assistance payments were issued. We examined daily sales of products in different categories by "peak" versus "nonpeak" sales days, and created two-tailed *t*-tests with unequal variances to examine whether product category sales differed significantly by "peak" and "nonpeak" days; $p < .05$ was considered statistically significant.

Second, we graphically displayed monthly revenue generated by different product categories over time. The sale of fruits and vegetables (as one of the main components of the intervention) was also examined visually over time. Given the store owners' negotiation with the landlords to supply fresh produce for the free snack program in November 2014 (described earlier), we present fruit and vegetable sales data with and without snack program sales to provide an accurate representation of fruit and vegetable sales to regular customers.

Results

Figure 1 shows the total daily sales (excluding lottery sales) of the pilot intervention corner store between August 2014 and April 2015. Figure 2 shows mean daily sales of different product categories sold during the peak sales days and the nonpeak sales days. During both peak and nonpeak sales days, transit passes and tickets, lottery tickets and cigarettes accounted for the highest overall sales. On peak sales days, mean daily sales of cigarettes were marginally significantly higher than nonpeak days ($175.73 for peak sales days compared to $130.09 for nonpeak sales days, $p = .084$). Mean sales of nonnutritious snacks and beverages were also marginally higher on peak days ($85.04 for snacks and $74.34 for beverages per day) than on nonpeak days ($61.67 for snacks [$p = .078$] and $56.39 for beverages [$p = .145$] per day). Lottery sales ($p = .023$) and public transit ticket sales ($p < .0001$) were significantly higher on peak than on nonpeak days.

Figure 3 shows monthly revenue generated from four product categories over time: fresh produce, snacks (including candy, chocolate, potato chips and other salty snacks and meat snacks), sweetened beverages and cigarettes. Throughout the course of the intervention, revenue from cigarettes was high. Revenue from fresh produce went from $165 in August 2014 to over $1000 per month for the months of January to April 2015. Revenue generated from fresh produce overtook revenue of sweetened beverages and snacks in January 2015, but fell slightly below sweetened beverage and snack revenue in March and April 2015.

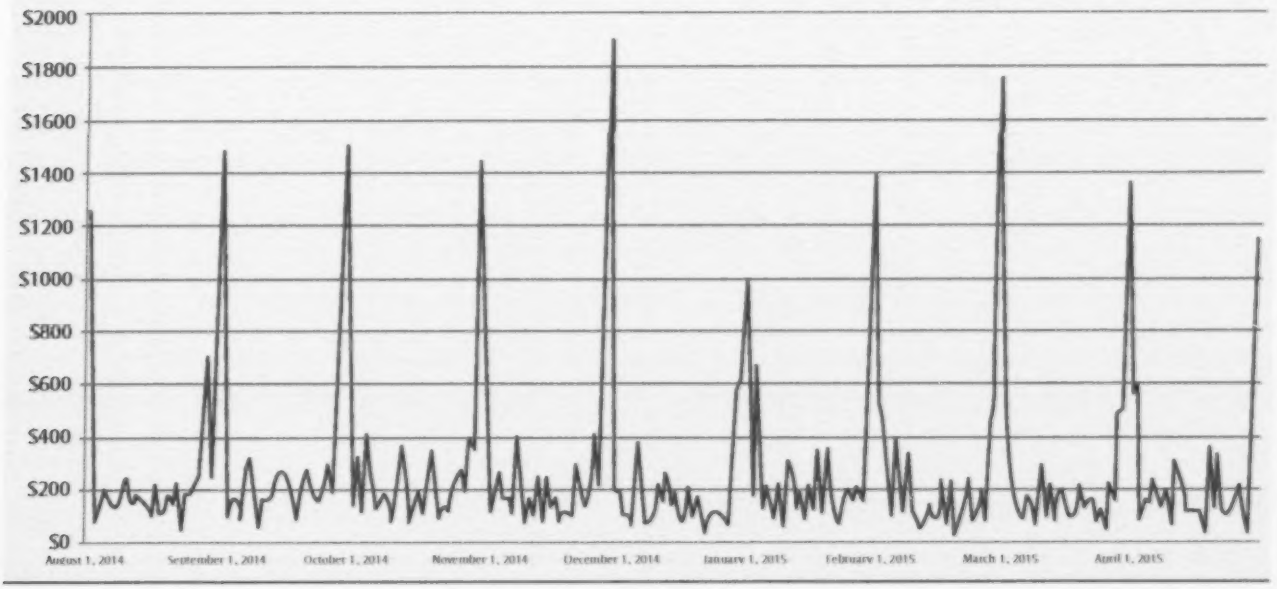
Finally, monthly gross revenue from fruits and vegetables by overall revenue and by revenue generated from individual consumer sales (i.e. excluding fruit and vegetable sales to the landlord) are presented in Figure 4. On average, the store generated approximately $935 in revenue from fresh produce per month over the six months that landlords purchased fruit through the intervention store.

Discussion

This exploratory study described the characteristics of sales data from a corner store participating in a government-led healthy corner store intervention in a low-income apartment tower neighbourhood in Toronto, Ontario. The data presented are among the first sales data to be examined in a study of retail food environment interventions in a Canadian context,[10,19] and the first sales data to be examined in a healthy corner store intervention in Canada. This study does not make claims about consumer-level impacts but more simply aims to characterize store revenue generated over the course of an intervention, along with potential interpretations of sales trends in relation to the urban small-store retailing context.

This study contributes three key findings relevant for research and public health practice in Canada. First, intervention store sales peaked at predictable time intervals (the day after social assistance cheques were issued). Furthermore, mean sales of some product categories varied significantly between these peak sales days and the other days of the month. Second, intervention store sales captured

FIGURE 1
Store total daily sales, excluding lottery sales, during a healthy corner store intervention in Toronto, Ontario, August 2014 to April 2015



longitudinal change in product mix over time. Third, reporting, visualizing and assisting the store owners with interpreting sales promoted the concept of data-driven decision making, and seemed to catalyze store owners' willingness to incorporate new products such as fresh fruits and vegetables.

Each of these findings is addressed in more detail below.

First, this is the first study, to our knowledge, to report how corner store sales peaked the day after social assistance cheques were issued in a low-income neighbourhood. This finding has implications for corner store interventions in similar neighbourhood contexts. Specifically, strategies to shift consumer purchasing behaviours on peak sales days (when store traffic may be higher), including in-store interventions, could be explored. The proportion of overall store sales from lottery tickets, transit tickets, cigarettes and

FIGURE 2
Average daily sales for different product categories for peak (highest sales days) and nonpeak days during a healthy corner store intervention in Toronto, Ontario, August 2014 to April 2015

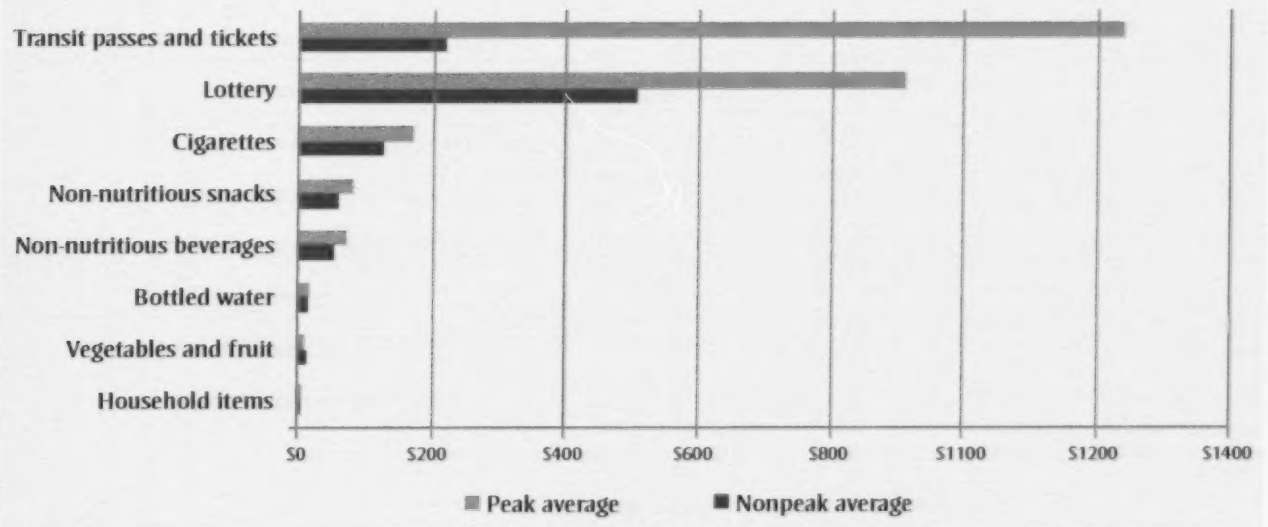
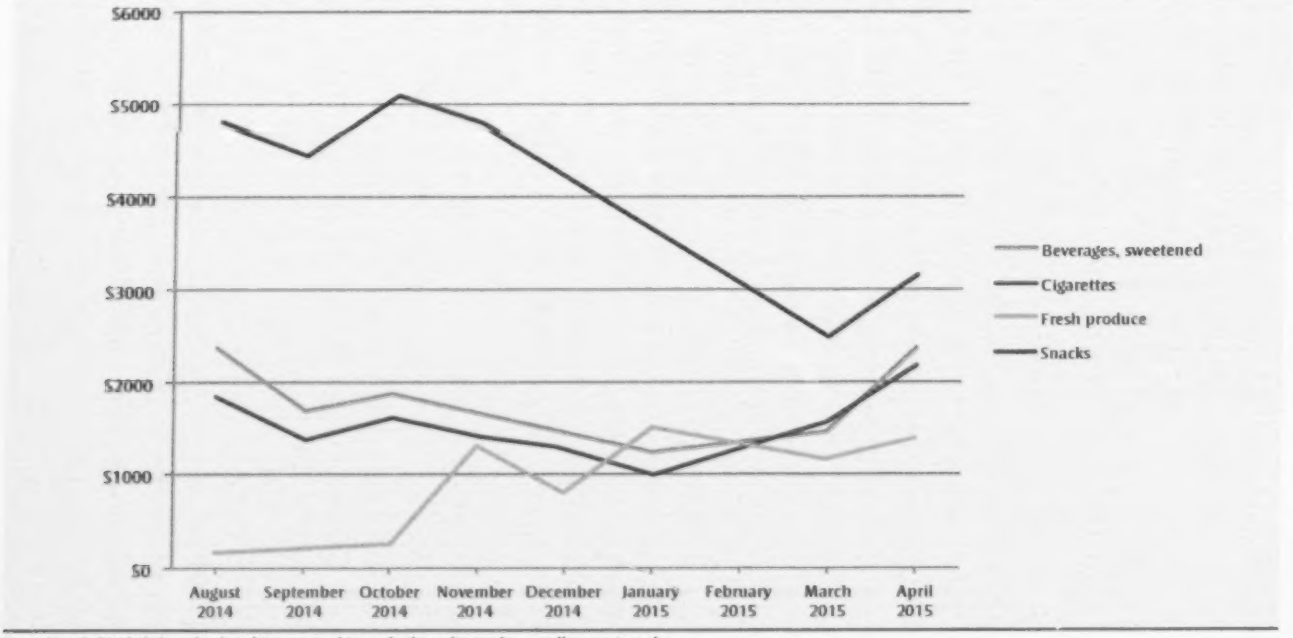


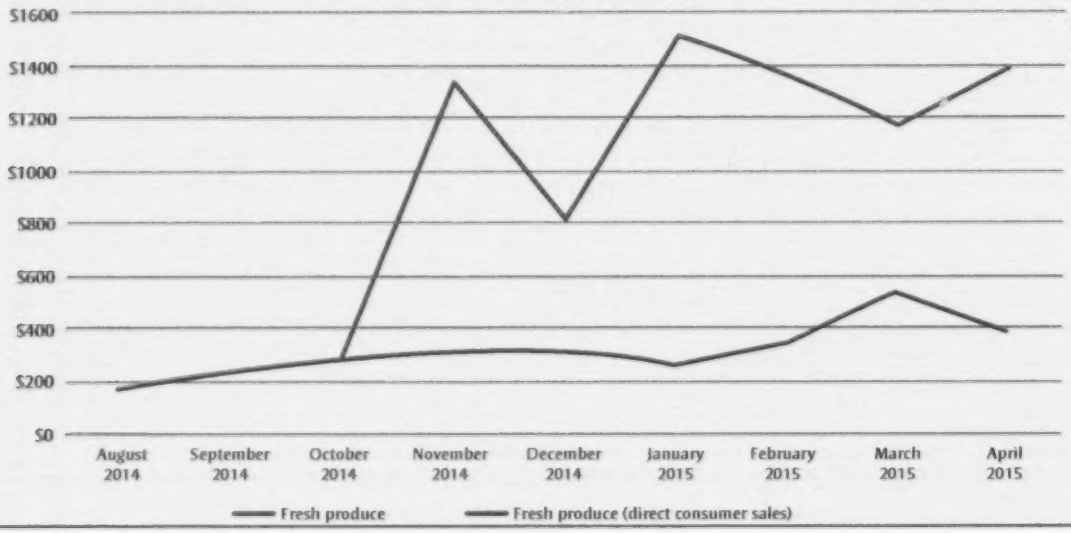
FIGURE 3
Monthly gross revenue from four product categories during a healthy corner store intervention in Toronto, Ontario, August 2014 to April 2015



Note: "Snacks" included candy, chocolate, potato chips and other salty snacks, as well as meat snacks.

nonnutritious snacks and beverages was significantly or marginally higher on peak days compared to nonpeak days, but there were no differences in sales of fruits and vegetables, bottled water or household items. These findings also highlight the importance of distinguishing between sales data analysis at an ecological (store or community) versus an individual level. The proportion of overall store sales from different product categories cannot be attributed to individual- or household-level characteristics. However, previous research with low-income families in Toronto has demonstrated the resourcefulness of those living under serious economic constraints manifested in household food insecurity,[25,26] and the wide array of factors contributing

FIGURE 4
Monthly gross revenue from fresh produce generated over the course of a healthy corner store intervention with and without fruit sales to landlords, Toronto, Ontario, August 2014 to April 2015



to decision making with household budgets. For example, among low-income families, while price is a key factor in purchasing decisions, and social assistance payments appear to structure monthly food purchases, economizing may depend on preference and health considerations, as well as perishability, durability and other value attributes associated with food items.[25] Future research should further explore reasons for differences in food purchasing over the course of a month, given more and less severe economic constraints at different times of the month.

Second, in terms of product mix, the use of sales data meant that we could explore longitudinal variation in sales of different product categories over time. In retail stores, the majority of sales typically come from a limited number of product lines, even with a diverse inventory. The intervention corner store primarily focussed on typical urban convenience store product lines, including tobacco, lottery, subway/bus tokens, sweetened beverages and unhealthy snacks. Over time, however, the introduction and promotion of various fruits and vegetables through the healthy corner store intervention saw these items gain a larger share of store revenue. Changing to a more health-promoting product mix in corner stores requires creativity and entrepreneurialism, as we have discussed elsewhere.[27] Although this study focussed on store sales, one substantial contribution to revenue—68% of total fruit and vegetable revenue—consisted of sales to the apartment tower landlord company, as described above. Irrespective of this unique opportunity, however, fruit and vegetable sales to individual customers also showed a steady increase over time, which is important to note for future healthy corner store programs for which bulk sales opportunities do not exist. That said, from a practical standpoint, creative approaches to financial sustainability for retail food environment interventions seem to be foundational for success.[20,28] Moreover, to the extent that small-store interventions become inclusive of other public health objectives (for example, reducing tobacco consumption), creative strategies to build consumer traffic and diversify revenue streams are required.

Third, reporting, visualizing and assisting the store owners with interpreting sales data promoted the concept of data-driven decision making, and seemed to catalyze store owners' willingness to incorporate new products such as fresh fruits and vegetables. Using sales data, the owners were able to objectively assess the revenue generated by different product categories, and to track which types of merchandizing most substantially increased sales of different nutritious foods, and when they did so. Moreover, summarizing sales data prior to the implementation of an intervention could provide an idea of the potential risks and benefits retailers face when intervening in certain product categories, which may help to guide intervention implementation.

Strengths and limitations

Strengths of this study include the use of objective sales data rather than store owner perceptions about store sales, which are commonly reflected in the literature.[7,29] In addition, it contributes to a new and growing body of literature that seeks to explore additional metrics of retail food environment intervention outcomes that have traditionally not been included in similar research (for a variety of reasons), particularly sales data.

Our study also has several limitations. First, we only examined sales data from one store. While this is a common approach in the literature,[7,30] our findings may not be generalizable to other Canadian settings or contexts.

Second, we were unable to report on sales data from the very beginning of the intervention, given difficulties in the consistent use of the POS system for the first several months. Conversations with the corner store owners revealed that while the technical use of the POS system was one issue, owners' business practices (e.g. not recording every item sold) also contributed to lack of consistent data collected during the first few months. A related limitation is that the POS system was not equipped to capture data on where purchased items were placed around the store (e.g. in high-traffic areas such as end-caps, or near the cash register), nor was it equipped to capture sales or promoted items. Future research could combine data from POS systems and planograms (diagrams that indicate the placement of retail products on shelves to maximize sales) to examine how sales of different nutritious products vary by placement.

Third, this study only examined revenue generated by different product categories, rather than profit (revenue less the cost of selling the item, including capital inputs, and taxation). Our sales data did not consider the number of items sold, but rather the overall sales in dollars. Therefore, we were unable to detect variation in the number of fruit and vegetable servings sold. Nevertheless, the store owners purposely set fruit and vegetable prices to be competitive with the nearest discount supermarket, so we anticipated that any slight price changes over time during our study would not have significantly impacted consumer behaviour (e.g. cause them to avoid the corner store). This is a limitation that should be addressed by future research. For example, although tobacco sales made up a substantial proportion of store revenue throughout the intervention, conversations with the store owners revealed their desire to stop selling tobacco because of the security risk it poses (in terms of theft) and because of diminishing profit margins. On the other hand, while fresh fruits and vegetables accounted for a smaller proportion of revenue, profit margins are typically high,[30] which provides a financial incentive for owners to continue to stock and sell these items.

Fourth, in addition to infrastructure investments (e.g. fridges and appropriate shelving), selling fresh food in a corner store requires substantial commitment on behalf of store owners and staff. Store staff must become skilled in food handling and safety training, developing relationships with suppliers, negotiating favourable prices and terms, displaying fresh produce, understanding customer needs and desires and finding revenue streams to reduce spoilage costs (for example, making sandwich wraps that use unsold fresh vegetables or installing a smoothie station for unsold fruit). Moreover, corner store owners often perceive that fresh produce will not sell, which may be based on previous experience.[20,30] Still, small-store interventions can significantly increase revenue generated from fresh produce sales, and therefore remain an important population health intervention for future research.[7,30]

Conclusion

Retail food environment interventions are gaining traction as a public health intervention with the potential for multiple

positive societal outcomes if enacted widely, including improved diet at a population level. Much research must still be done to further describe metrics for the success of these types of interventions for different audiences, recognizing the competing priorities of diverse stakeholders. Sales data are critical in evaluating the economic feasibility of stores adapting their business models to support healthy diets in Canada, but often such data are proprietary and collecting them for public health research requires partnerships between industry and public sector researchers. Public–private partnerships are a current and contentious issue in Canada's public health community, and tools for guiding public health actors in partnership development for food-related partnership are available.[51] Future interventions and research would do well to carefully consider partnerships and success metrics for retail food environment interventions in diverse Canadian contexts.

Acknowledgements

We would like to gratefully acknowledge the reviewers who provided excellent suggestions on previous versions of this manuscript. LMM also acknowledges funding from the Canadian Cancer Society in the form of a Career Development Award in Cancer Prevention (#704744). This research was funded by the Public Health Agency of Canada.

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

LMM conceived of the study and co-wrote the manuscript with ML. BEC conducted data analyses. LMM, BEC, and CLM devised and implemented the overarching FRESH study. All authors informed the data analysis, assisted in the interpretation of results, critically revised the manuscript, and approved the final version.

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Food deserts in Winnipeg, Canada: a novel method for measuring a complex and contested construct

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Abstract

Introduction: "Food deserts" have emerged over the past 20 years as spaces of concern for communities, public health authorities and researchers because of their potential negative impact on dietary quality and subsequent health outcomes. Food deserts are residential geographic spaces, typically in urban settings, where low-income residents have limited or no access to retail food establishments with sufficient variety at affordable cost. Research on food deserts presents methodological challenges including retail food store identification and classification, identification of low-income populations, and transportation and proximity metrics. Furthermore, the complex methods often used in food desert research can be difficult to reproduce and communicate to key stakeholders. To address these challenges, this study sought to demonstrate the feasibility of implementing a simple and reproducible method of identifying food deserts using data easily available in the Canadian context.

Methods: This study was conducted in Winnipeg, Canada in 2014. Food retail establishments were identified from Yellow Pages and verified by public health dietitians. We calculated two scenarios of food deserts based on location of the lowest-income quintile population: (a) living ≥ 500 m from a national chain grocery store, or (b) living ≥ 500 m from a national chain grocery store or a full-service grocery store.

Results: The number of low-income residents living in a food desert ranged from 64 574 to 104 335, depending on the scenario used.

Conclusion: This study shows that food deserts affect a significant proportion of the Winnipeg population, and while concentrated in the urban core, exist in suburban neighbourhoods also. The methods utilized represent an accessible and transparent, reproducible process for identifying food deserts. These methods can be used for cost-effective, periodic surveillance and meaningful engagement with communities, retailers and policy makers.

Keywords: food desert, GIS, food security, Canada

Highlights

- Although "food deserts" are a contested concept, it is useful to measure and describe them to stimulate discussion about how to address food insecurity and inequity issues.
- In 2014, 9% of the Winnipeg Health Region population was living in an urban food desert, defined as having low income and living ≥ 500 m from a national chain grocery store or a full-service grocery store.
- The majority of food desert neighbourhoods were concentrated in the downtown area of Winnipeg; however, there were several affected neighbourhoods in the outer suburbs.
- Simple and cost-effective methods using income, location of food stores, population counts and on-the-ground verification can defensibly identify the location and size of urban food deserts, and be used for ongoing surveillance.
- Failure to include local full-service grocery stores when identifying food deserts may lead to an overestimation of their size.

Introduction

"Food deserts" have emerged over the past 20 years: residential geographic spaces, typically in urban settings, where low-income residents have limited or no access to retail food establishments with sufficient variety at affordable cost.[1] They are spaces of concern for communities, public health authorities and researchers due to their potential negative impact on diet quality and quantity. Residents of food deserts may effectively be dependent on small retailers, such as convenience stores, with limited selection and typically higher prices, for the bulk of their food purchasing. Their situation is exacerbated since they may not have the financial resources to own a car, or have adequate alternative transportation means.[2,3] The lack of full-service, fair-priced grocery stores in a community may therefore promote inequities by leaving residents at increased risk of compromised diet quality, negatively impacting long-term health.[4-6]

It is important to note, however, that no common definition of "food desert" exists, and the literature contains a variety of constructs, primarily based on the methodologies used, that vary greatly.[7,8] Some

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authors question the usefulness of the food desert construct, arguing it obfuscates the priority issue of inadequate income, regardless of one's proximity to a full-service grocer.[9] Others have attempted to incorporate this dimension using the concept of "food mirages"—neighbourhoods that have full-service stores, yet remain inaccessible to low-income residents because of lack of purchasing power.[10,11] One may therefore conclude that food deserts are a contested concept, with constructs and methodologies continuing to emerge.

To date, the presence and characteristics of food deserts have been studied primarily in urban settings including Australia, the UK, the United States and Canada.[12-16] Results of this research are equivocal. A review by Beaulac et al.[17] found that clear disparities in food access exist by income and race in many municipalities in the United States, but not elsewhere. Food deserts have been identified in cities in Australia[12] and the UK;[18] however, in the latter, the establishment of a full-service grocer did not alter residents' diets.[19] Research from Canada indicates that some cities have food deserts, including London, Ontario, where low-income inner-city residents were shown to have the poorest access to supermarkets,[20] and Gatineau, Quebec, where 7.5% of the population live with limited financial resources along with low access to healthy food.[21] Low income is not always associated with poor food access, however. While more extensive food deserts have been found in some low-income Edmonton and Saskatoon neighbourhoods, others are located in areas with high access to grocery stores.[22,23] Similar trends have been found in southern Ontario urban centres.[15,24] These findings were confirmed in a recent review of Canadian food environments by Minaker et al.,[25] who concluded that food desert patterns were more pronounced in the United States than Canada, where many deprived urban neighbourhoods have access to healthy food as good as, in some cases better access than wealthier neighbourhoods.

Even within urban areas, different conclusions about the presence and characteristics of food deserts have been drawn. For example, three studies in the city of Montréal, Quebec, came to different conclusions. Apparicio and colleagues found that geographic accessibility of healthy food was not an issue, and therefore concluded that food deserts are not a problem in Montreal.[26] Bertrand and colleagues concluded that a significant proportion of the population without vehicles had poor access to fruits and vegetables.[27] Páez and colleagues, while not using the term "food deserts," found differential access to healthy food among poor Montréal residents depending upon where they lived.[2] The diverse and often contradictory nature of these findings are due to the diverse methods used to identify and define food deserts, including the spatial methods deployed, whether access to transportation was factored in, the type and variety of retail stores used in the analysis, the granularity and complexity of the methods used, and whether inputs and results were validated through appropriate qualitative methods.

A significant challenge with many food desert studies is that their complex methods and detailed inputs, often requiring significant primary data collection, may make them difficult and expensive to replicate. For example, Luan's work,[24] while producing a very detailed assessment of the Waterloo food environment, utilized a number of complex variables and methods (e.g. "relative healthy food access," spatio-temporal trends and hierarchical modelling) that would be difficult and expensive to replicate. In addition, complex methods may hinder effective knowledge translation of results to nonacademic audiences, as methods that are difficult to explain may have less credibility with community members and policy makers. Further, given the dynamic nature of the contemporary foodscape, where retailers routinely leave or enter a community, it is critical to be able to update food desert analyses regularly so they are current and relevant; complex, resource-intensive methods may make this challenging to do in a timely fashion.

Despite the contested nature of food deserts, and the lack of consensus on the appropriate methods to measure and describe them, they nonetheless have become an important concept that facilitates discussion, debate and negotiation within communities, and between communities and policy makers, about how to address food insecurity in the context of modern foodscapes.[28] The term *food desert* has achieved "brand recognition" in the fields of community development and public health, even if there is disagreement on what constitutes a food desert, which is useful for focussing attention on issues around food environments and food insecurity. Consequently, the purpose of this study was to demonstrate the feasibility of implementing a reproducible method of identifying food deserts using minimal resources, and with data easily available in the Canadian public health context. As onerous methods are beyond the scope of the vast majority of public health departments in Canada, this approach provides a pragmatic model for implementing foodscape surveillance in applied public health settings.

Methods

The study took place in the Winnipeg Health Region, which is made up of the City of Winnipeg and two adjacent rural municipalities. The Winnipeg Health Region is located in the central Canadian province of Manitoba, and in 2014 had a population of 736 000.

We used three data sources (described below) to create two food desert scenarios (Table 1) based on proximity to two categories of retail food stores: national chain grocery stores and full-service grocery stores. "National chain grocery stores" were defined as large, full-service grocery stores that had stores in Manitoba as well as other provinces. "Full-service grocery stores" were defined as large, local grocery stores (not national chains) carrying

TABLE 1
Scenarios used to determine food deserts in Winnipeg, Manitoba, Canada

Food desert scenario 1	A dissemination block in the lowest income quintile, and Dissemination block centroid ≥ 500 metres from a national chain grocery store.
Food desert scenario 2	A dissemination block in the lowest income quintile, and Dissemination block centroid ≥ 500 metres from a national chain grocery store OR a full-service grocery store.

a good selection of self serve fresh fruits and vegetables (i.e. more than potatoes, onions and bananas, and not prepackaged), fresh meat and dairy products at reasonable prices (i.e. close to national chain prices), as assessed by local public health dietitians participating in the study, who had excellent knowledge of local stores, food costs and store characteristics. Dietitians were provided with lists of candidate stores, and judged whether they were appropriately classified; they also identified stores that were missing from the list, and any stores that had subsequently closed.

First, we constructed a database of all national chain and full-service grocery stores currently operating in the Winnipeg Health Region. The data was initially culled from the Winnipeg and area telephone Yellow Pages (not digital). Community dietitians and community facilitators from the Winnipeg Regional Health Authority verified and refined the initial database of food stores to ensure it reflected what was in their community.

Second, we used the 2011 Canadian census data at the dissemination-area level to classify the 5500 dissemination blocks within the Winnipeg Health Region into quintiles by average household income, using the income cut-offs defined by the Manitoba Centre for Health Policy.[29] Each income quintile contains approximately 20% of the Winnipeg population (Table 2). In our study, average household income is used as a population-level indicator of food purchasing power as well as a proxy indicator of potential car ownership. Dissemination blocks were attributed with the income quintile classification of the dissemination area they fell into. Dissemination areas are the smallest geographic unit for which Statistics Canada disseminates detailed census information; in the Winnipeg Health Region there are 1150 dissemination areas. Dissemination blocks are smaller than dissemination areas (there are approximately five dissemination blocks for each dissemination area), but do not contain detailed census data.

Third, we derived total population counts from the 2014 Manitoba population health registry,[30] with population data geocoded to the dissemination block–level using six-digit postal codes.

Fourth, to identify the two food desert scenarios, the geodesic distance (the shortest distance "as the crow flies") from the centroid of each of the 5500 dissemination blocks to the nearest national chain or full-service grocery store was calculated. We chose this method as it improves replicability without greatly affecting results. We used a distance of 500 metres or less as a reasonable "walkable" distance to a grocery store, a distance that has been used by other researchers.[4,31] Since the weather in Winnipeg is very cold, with snow on the ground for over one-third of the year from November until early April, we assessed that 500 metres was a reasonable distance for people to walk with the additional burden of groceries, and possibly children.

Finally, we classified dissemination blocks as food deserts under the two scenarios outlined in Table 1. The total population residing in all identified food deserts within the Winnipeg Health Region was then calculated by summarizing the population count in those dissemination blocks classified as food deserts. All calculations were undertaken in Epi Info version 3.5.4[32] using automated scripts, and tabular outputs exported into ArcGIS 10.2[33] for mapping.

TABLE 2
Winnipeg Health Region income ranking by quintile, Winnipeg, Manitoba, Canada

Quintile	Average household income of lowest earning dissemination area within quintile ($)	Average household income of highest earning dissemination area within quintile ($)
1	14 772	49 506
2	49 509	63 475
3	63 513	78 890
4	78 957	98 953
5	98 963	343 154

Data source: Statistics Canada. 2011 Census of Population.

Results

Figure 1 shows the distribution of dissemination blocks by income quintile within the Winnipeg Health Region. While the majority of low-income geographies are located in the downtown core of Winnipeg, additional low-income areas are located in the outer suburbs.

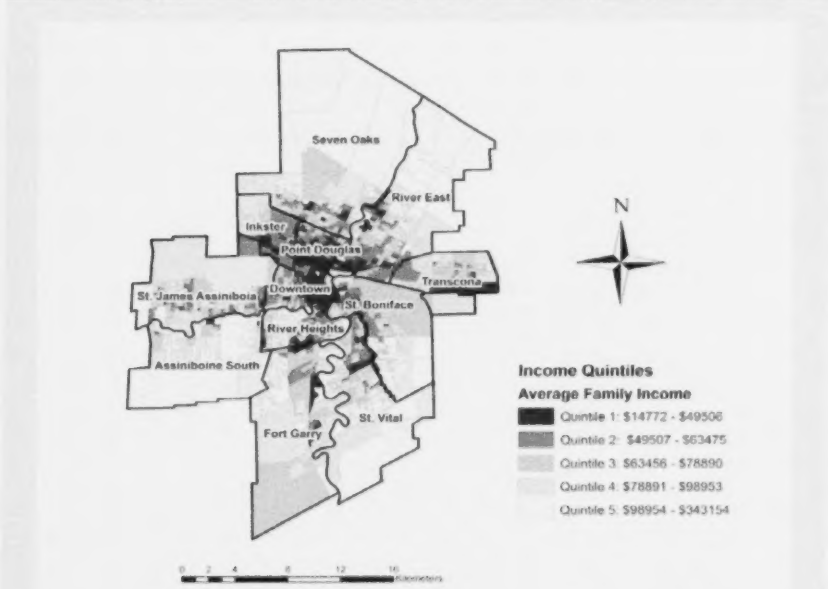
Figure 2 shows the location of food deserts in the Winnipeg Health Region under scenario 1, which used the distance to the nearest national chain grocery store in low-income neighbourhoods. This method classified a substantial cluster of dissemination blocks as food deserts in the downtown area of Winnipeg, with a smaller number of dissemination blocks fitting the food desert criteria scattered throughout the suburbs. Under scenario 1, there were 104 335 people (14.49% of the population) living in food deserts in the Winnipeg Health Region in 2014.

Figure 3 shows the location of food deserts under scenario 2, which used the distance to either a national chain grocery store or a full-service grocery store in low-income neighbourhoods. As shown, the inclusion of full-service grocery stores in the analysis results in a substantially smaller number of dissemination blocks being classified as food deserts in the downtown area compared to scenario 1. Most of the food desert locations in the outlying suburbs identified in scenario 1, however, remain in scenario 2. Under scenario 2, there were 64 574 people (9.1% of the population) living in food deserts in the Winnipeg Health Region in 2014.

Discussion

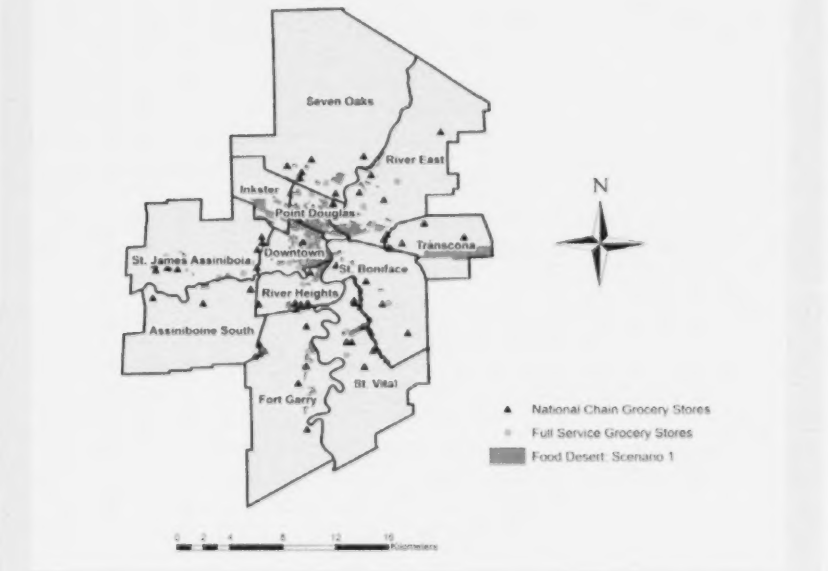
The results of this study suggest that food deserts exist within the Winnipeg Health Region and affect a significant proportion of the population. This study implemented two food desert scenarios, based upon proximity to national chain grocery stores only, or to either national chain or local full-service grocery stores, among residents living in low-income areas. Under the best-case scenario, where we used proximity to either national chain or local full-service grocery stores, it is estimated that 9% (almost 1 in 10) of Winnipeg residents live in a food desert. If proximity only to a national chain food store was used, almost 15% (or 1 in 8) of Winnipeg residents (104 335) were identified as living in a food desert. The maps show that

FIGURE 1
Average household income by income quintile, Winnipeg Health Region, 2011



Data source: Statistics Canada. 2011 Census of Population.

FIGURE 2
Food desert scenario 1: food deserts in the Winnipeg Health Region, based only on proximity to national chain grocery store



while food deserts are concentrated in the downtown area of the Winnipeg, pockets of suburban food deserts also exist. These results are consistent with results found in some other Canadian cities, which identified a significant number of low-income residents with poor access to healthy food sources.[10,20,21,23]

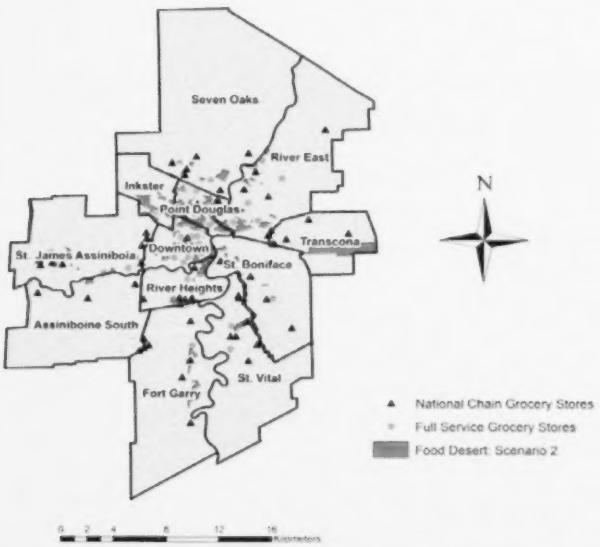
Winnipeg has one of the largest populations of urban poor in Canada, with 17.5% of the population living in low-income circumstances, compared with 9% of the overall population in 2010.[34] More specifically, the downtown residential areas in Winnipeg most highly affected by food deserts, Downtown and Point Douglas, had median household incomes in 2010 of $36 298 and $39 614 respectively, compared to $58 503 for the Winnipeg Health Region as a whole.[35] A low income reduces transportation options, and inadequate access to affordable transportation has been shown to be a barrier to accessing sufficient, healthy food.[2,3] Lower-income households have less access to personal vehicles and drive less than their higher-income counterparts.[36,37] Lack of easy access to affordable and nutritious food coupled with low income creates a double burden for a significant number of Winnipeggers living in food deserts. They must therefore either rely on alternate food sources such as convenience stores, food banks and low-cost fast food options such as "dollar" pizza and other bargain fast food outlets; or rely on taxis (which are expensive) or personal networks (which can be inconvenient and unreliable), if available, for rides to and from larger grocery stores.

The observation that food deserts persisted in suburban neighbourhoods, even when accounting for full-service grocery stores, indicates that these neighbourhoods are mainly serviced by large national chain stores. This is consistent with trends observed in grocery retailing, where larger, corporate chain stores are displacing smaller chains and independent stores in what Bedore refers to as a "scaled-up, disembedded [food retail] industry that now dominates the landscape."[38]

Strengths and limitations

This study makes a unique contribution to the food and built environment literature in terms of methodology. First, this study has demonstrated that a relatively simple, reproducible approach that uses only

FIGURE 3
Food desert scenario 2: food deserts in the Winnipeg Health Region, based on proximity to either a national chain grocery store or a full-service grocery store



three data inputs (food store locations, household income and population counts) can be used to generate a defensible food desert analysis for a large urban centre. This pragmatic approach is especially important as public health departments do not typically have the resources to engage in complex food environment analyses on an ongoing basis. Furthermore, we have found that the relative simplicity of our methods has facilitated knowledge mobilization with key community stakeholders including community nutritionists, food activists and policy makers.

Second, this study has demonstrated that all calculations for the identification of food deserts can be implemented using automated scripts in Epi Info software with tabular outputs that can be easily imported into ArcGIS for mapping. The advantage of this approach is that when new updates are required (i.e. when a food store opens or closes down, or if there is an interest in exploring the impact of different proximity inputs), the food desert analysis can be updated quickly and easily. This actually occurred during our study period (several food stores closed, and two opened), and we were able to re-run our analysis and produce updated maps and population estimates with minimal effort and resources.

Third, this study has demonstrated that using only proximity to large national chain food stores, as has been undertaken in other food desert analyses in Canada,[21] may in fact result in an overestimation of the size of food deserts and the population affected. In many downtown areas, smaller local grocery stores may play an extremely important role in providing easy access to a wide range of affordable food products. As shown in this study, taking into account proximity to local full-service grocery stores in additional to national chain stores decreased the estimate of the population affected by food deserts in the Winnipeg Health Region by 38%, from 104 335 to 64 574 individuals.

Our study has a number of limitations that must be taken into account when interpreting its results. First, we assigned income ecologically to individuals based upon residence in a low-income dissemination area. It is possible that there may be high-income individuals in our study living in low-income dissemination areas who do not experience economic and transportation barriers to accessing an adequate range of healthy food, and this may have resulted in an overestimation of the size of the population living in food deserts in the Winnipeg Health Region. This overestimation may be offset, however, by low-income individuals living in high-income dissemination areas who did not get counted as living in a food desert in our study.

Second, our study used geodesic distance ("as the crow flies") instead of network distance (distance one would actually have to travel along a street network) to estimate the travel distance to the nearest food store. Although this may have added some inaccuracies to our distance calculations, the error this introduced was likely minimal in the downtown neighborhoods of Winnipeg where the majority of the food deserts were identified. In downtown Winnipeg, there is a very tight street network structure (i.e. short blocks, many cross-streets), which means that geodesic and network distances would likely be similar since residents can pick many straightforward routes to get from their residence to a food store. In suburban neighbourhoods this may have led to more misclassification due to less tightly structured street networks.

Third, our study did not specifically take into account public transportation options when identifying food deserts. However, we believe that our use of household income is a good proxy of people's financial ability to easily transport themselves to the nearest food store by car, taxi or bus. In Winnipeg, bus fare is expensive (especially if a parent is also paying for accompanying children; for example, 1 × $2.70 adult fare plus 2 × $2.20 child fare adds up to $14.20, round trip) and the existence of a local bus route would not necessarily increase access to a distant food store (especially also if one is bringing home a large volume of groceries). Furthermore, in Winnipeg, bus routes from central neighbourhoods to larger stores in suburban areas are often sporadic and inconvenient.

A final limitation of this study was that no structured metric (e.g. formal costing or objective assessment of food availability at the store level) was implemented in order to classify stores. As indicated earlier, candidate stores were initially identified through the local Yellow Pages, with validation by community dietitians working for the local regional health authority.

Formally evaluating the characteristics of the retail food environment (cost and variety) is challenging and resource intensive; this may explain why other food desert studies have restricted their analyses only to the obvious large national chain food stores that are easy to identify. Resources permitting, we suggest that future studies should attempt to more formally evaluate cost and variety characteristics of local stores, with quantifiable criteria. We would argue, however, that in this study the verification undertaken by local public health dietitians is defensible given their intimate knowledge of local communities, and the limited resources available. Future studies should examine the impacts of food deserts on dietary behaviour and health outcomes, as well as residents' experiences of living in food deserts.

Conclusion

This study has demonstrated that the presence of food deserts in Winnipeg, a city with persistently high rates of poverty, affects nearly one in 10 citizens. We found that areas of food deprivation and low income were clustered in the "core" or centre of the city; however, there were affected communities in suburban areas. The novel methods utilized in our study represent a transparent, reproducible process for routine surveillance and meaningful engagement with communities, retailers and decision makers. The inclusion of local full-service grocers in addition to national chain grocery stores provides a more realistic assessment of food desert existence. While adequate income is a priority for addressing food insecurity, assessing the prevalence of food deserts and presenting the data in an accessible manner also allows for knowledge mobilization and the addition of other important sociodemographic and foodscape data into the analysis. Our food desert outputs were formatted as spatial files, meaning that food desert layers may in the future be overlaid with other relevant data in both static maps and interactive mapping applications such as Google Earth,[39] providing a powerful tool for engaging stakeholders.

Acknowledgements

The authors would like to acknowledge the invaluable assistance of the Winnipeg Regional Health Authority public health dietitians in completion of this study.

Conflicts of interest

The authors have no conflicts of interest.

Authors' contributions

JS, CG and SE contributed to the study concept, data analysis and writing of the manuscript. MJ contributed to data analysis. All authors assisted in interpretation of results, manuscript revision and approved the final version.

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Status report

Geographic retail food environment measures for use in public health

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Abstract

The Association of Public Health Epidemiologists in Ontario (APHEO) Core Indicators Work Group standardizes definitions and calculation methods for over 120 public health indicators to enhance accurate and standardized community health status reporting across public health units in Ontario. The Built Environment Subgroup is a multi-disciplinary group made up of planners, researchers, policy analysts, registered dietitians, geographic information systems (GIS) analysts and epidemiologists. The Subgroup selected and operationalized a suite of objective, standardized indicators intended to help public health units and regional health authorities assess their community retail food environments. The Subgroup proposed three indicators that use readily available data sources and GIS tools to characterize geographic access to various types of retail food outlets within neighbourhoods in urban settings. This article provides a status report on the development of these food environment indicators.

Keywords: measurement, food environment, urban environments, food retail, built environment

Highlights

- Environmental factors (such as the unhealthy food retail that is easily accessible throughout communities) are gaining recognition as important determinants of food choice and diet-related health outcomes such as obesity.
- There is a lack of consistency in food environment measures, which is problematic for the many jurisdictions across Canada interested in implementing policies to improve the food environment.
- This paper provides a status report on recent work done to develop a set of standardized, objective indicators (i.e. measures) to aid public health units and regional health authorities assess their community food environments within urban settings.
- Three indicators were selected to assess different dimensions of the community food environment: (1) intensity (i.e. density) of food outlets; (2) the relative density of less healthy food outlets; and (3) proximity of the population, living in specific geographic areas, to food outlets.

Introduction

Poor diet and excess body weight account for a significant share of disease burden in Canada and are among today's most pressing public health challenges.[1-4] The vast majority of Canadians do not consume a healthy diet[5] and the prevalence of obesity has tripled over the past three decades.[6] In 2011 to 2012, one in four or 6.3 million Canadians had obesity,[7] and in 2012 to 2013, 62% of Canadian adults were overweight or had obesity based on measured height and weight data.[8] Dietary patterns and body weight are complex issues influenced by biological, behavioural and contextual factors.[9,10]

The food environment is gaining recognition as a major determinant of food choices and diet-related outcomes such as obesity.[10,11] Thus, a promising approach to improving population-level dietary patterns and associated health outcomes is to intervene in the environments in which food purchasing and consumption decisions are made.[12-16]

Food environment researchers acknowledge the complex psychosocial and environmental factors influencing dietary habits, and have investigated various aspects of the food environment in relation to food purchasing and consumption behaviours, and related health outcomes.[17-21] In Glanz and colleagues' foundational paper on healthy nutrition environments,[19] the food environment is conceptualized to consist of multiple dimensions, including the media environment, organizational environments (e.g. schools and workplaces), the community environment (i.e. type and location of stores and restaurants in neighbourhoods) and the consumer environment (i.e. availability, price and promotion of foods in

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stores and restaurants). Assessment of and interventions within the organizational food environment has been the focus of much research to date.[22-24] The body of research on community and consumer environments has also grown considerably over the past decade, employing hundreds of different food environment measures.[25] The use of inconsistent and diverse food environment measures has been regularly identified as a key limitation in this field of research.[17,18,20] Measures of the consumer environment tend to be resource-intensive to implement (e.g. inventory-type measures to assess the availability and pricing of specific foods and beverages or the shelf space dedicated to fruits and vegetables). Therefore, the current report focusses on describing methods for the consistent assessment of *community* food environments across Ontario health units, using standardized measures that are feasible to implement.

Despite the growing interest over the past decade in the health impacts of food environments, the overall pattern of findings remains inconsistent.[17,18,20] One reason for this may be the hundreds of different measures used to assess the food environment,[18,20,25-27] which challenge researchers' ability to compare results of different studies across populations, social and economic contexts, geographic regions and trends over time.[17,18,27-29] This lack of consistency in food environment measures is also problematic for the many jurisdictions across Canada interested in implementing policies to improve the food environment, but challenged by a lack of guidance on how best to assess their local food environments.[30]

This paper provides a status report on recent work done by the Association of Public Health Epidemiologists in Ontario (APHEO) to develop a set of standardized, objective indicators (i.e. measures) to aid public health units and health authorities in assessing their community food environments within urban settings. These indicators use readily available datasets and geographic information systems (GIS) methodology to characterize geographic access to various types of retail food outlets within neighbourhoods in urban settings.

APHEO Built Environment Subgroup

The Built Environment Subgroup* of the APHEO Core Indicators Work Group recognized the need of public health practitioners to assess their local food environments and identified the lack of consistent assessment tools as one of the largest practice gaps.

Indicator selection and adaptation

A nonsystematic scoping review of the literature was conducted for the Subgroup in 2014. PubMed, Web of Science and Scopus were searched for peer-reviewed articles published in English at any time up to and including May 2014. We used a variety of search terms including "food/nutrition environment" and "retail food access" to identify studies that reported quantitative findings on some aspect of the retail food environment in relation to dietary or weight-related outcomes. Reviews, conceptual papers and commentaries were also included, as were studies of the school food environment. The quality of studies and the psychometric properties of food environment measures in the reviewed studies were not assessed. As selection and adaptation of the indicators unfolded, key empirical and review papers published after May 2014 were also reviewed by the Subgroup.

We reviewed article titles and abstracts, and selected 190 articles from the search results. Consistent with a number of previous systematic reviews of food environment studies,[17,18,20,31,32] our literature scan found that of the different dimensions of the food environment,[19] the community food environment (i.e. geographic access to local retail food outlets) has been studied most extensively, potentially due to the ease of obtaining the required retail food data and the growing availability of GIS-based tools.[31,32] Given that the availability of reliable data and GIS tools are critical to public health for monitoring, surveillance and awareness building, objective measures of geographic access to food retail within communities were selected as the primary area of focus for our indicator selection.

Similar to findings from previous systematic reviews, we found that objective measures of geographic access to local stores and restaurants are commonly classified into three types of measures: density, proximity and variety.[17,18,20,27,31] Density measures typically assess the concentration of outlets (i.e. number) per neighbourhood population or geographic area. Proximity is most commonly measured as the distance between a location (e.g. residential area or school) and the nearest outlet of a particular type (e.g. grocery or convenience store). Finally, variety measures attempt to reflect the relative mix of various types of outlets within a particular area. Such measures have been used in a number of recent investigations of the local food environment,[33-36] and can be used in conjunction with other community food environment measures (such as in-store assessments) or layered with demographic information to provide a comprehensive understanding of the retail food environment at varying geographic scales (e.g. at the neighbourhood, municipal or regional levels).

Following our review of the existing literature, we chose three indicators reflecting different dimensions of the community food environment: (1) intensity (i.e. density) of food outlets; (2) the relative density of less healthy food outlets; and (3) proximity to food outlets. These indicators reflect the most commonly studied objective aspects of geographic food access in communities, and can be readily created in Ontario using a health unit's existing food premise inspection database, standard geographic units from the Canadian census (or custom geographic units, if available), and the Ontario Road Network (or another road network file) in a GIS environment. All indicators measure the food environment within 1000 m (approximately a 10- to 15-minute walk) from residential areas, a distance that has been commonly used[37-39] in previous studies to represent a neighbourhood environment easily accessible by walking.[34,35,40]

Indicator definitions

1. **Density:** population-weighted average number of food outlets of a given category within 1000 m† of dissemination block (DB)

* The APHEO Built Environment Subgroup is an interdisciplinary team of public health planners, researchers, policy analysts, public health nutritionists, GIS analysts and epidemiologists.

† 1000 metres is considered to be approximately a 15-minute walk for an adult in an urban setting.[12]

centroids per dissemination area (DA)[i] (or another geographic area of interest, such as the household vicinity).

$$\text{Density of food outlets} = \frac{\sum_{\text{All DBs in a DA}} (\text{DB population}) \times (\text{\# of food outlets of a given category within 1000 m of DB centroid})}{(\text{total population of DA})}$$

2. **Relative density** (also known as the Modified Retail Food Environment Index [mRFEI]): ratio of unhealthy food retailers to both healthy and unhealthy food retailers within 1000 m of DBs per DA (or another, larger geographic area of interest, such as census tracts, administrative division or neighbourhood).

$$\text{Modified Retail Food Environment Index} = \sum_{\text{All DBs in a DA}} \frac{\text{\# less healthy food retailers within 1000 m of DB centroid}}{\text{\# of healthy + \# less healthy food retailers within 1000 m of DB centroid}} \times 100$$

3. **Proximity:** Population-weighted mean network distance (metres) between dissemination block (DB) centroids and nearest food outlets of a given category per dissemination area (DA) (or geographic unit of interest).

$$\text{Proximity to food outlets} = \frac{\sum_{\text{All DBs in a DA}} (\text{DB population}) \times (\text{distance from DB centroid in metres to nearest food outlet of a given category})}{(\text{Total population of DA})}$$

Classification of food retail types

Food retailers can be classified into different categories using Standard Industry Classification (SIC) codes or the newer system of North American Industry Classification System (NAICS) codes.[43,8] These indicators of intensity and proximity can be calculated either for a specific outlet category (e.g. supermarket) or for a range of outlets classified as healthy or unhealthy, as indicated for the relative density indicator (i.e. a measure of the relative density of outlets offering unhealthy options).[46-48] Previous studies have commonly classified supermarkets, grocery stores and fruit and vegetable markets as "healthy" food retail, while convenience stores and fast-food (i.e. limited-service) restaurants have been classified as "unhealthy" retail food outlets.[44,49,50] While it is acknowledged that highly processed foods that are energy-dense and nutrient-poor can be purchased at "healthy" food retailers (e.g. supermarkets) and minimally processed nutrient-dense foods can be purchased at "unhealthy" food retailers (e.g. convenience stores or limited-service restaurants offering vegetables, fruit or less processed items), previous research has found that the consumer nutrition environment—food purchasing cues within stores and restaurants—varies by outlet type.[49,51,52]

Discussion

A retail food environment that promotes and supports access to and availability of healthy food choices is one aspect of a healthy neighbourhood design and built environment. Assessing geographic access to food retail either independently or alongside additional consumer nutrition environment measures (i.e. in-store or in-restaurant audits) can provide a method for health units to characterize the local retail food landscape and thus increase their understanding of how community design impacts the health and well-being of populations. Other methods, such as questionnaires, interviews and store and restaurant inventory measures, can be used to measure resident perceptions of the food environment or the availability and price of nutritious food.[32,53]

Strengths and limitations

The APHEO Core Indicators were developed in order to systematically define and operationalize a core set of health indicators due to a recognized need for consistency among health reports and to enable true comparisons across health units. They describe complex concepts in a concrete, clearly defined way using standardized definitions and methods and form the foundation for community health status reporting in public health in Ontario. The three indicators of the community food environment presented in this report (i.e. intensity, relative density and proximity) are the first set of core indicators on the food environment in Ontario and will allow health units to monitor their food environment and examine associations with various health outcomes or socioeconomic data. As municipalities across Canada and globally are increasingly considering or implementing different policies to affect the local food environment (e.g. zoning by-laws to restrict fast-food outlets in certain areas), these indicators will enable health units to monitor the impact of these policies on a variety of health outcomes. Moreover, these indicators are consistent with those recently proposed by the international INFORMAS framework to monitor and benchmark community food environments.[37] As such, the use of indicators outlined in this paper can potentially contribute toward international efforts to monitor local food environments in a consistent way, which is critical for the development of effective policy interventions.[37]

While the three indicators of the community food environment outlined in this paper were created in part to reflect the legislative requirements set in the Ontario Public Health Standards,[54] they can be used by other regional health authorities to characterize their food environments since the indicators were designed for use by public health practitioners. Additionally, in an attempt to leverage complementary work, the APHEO Built Environment Subgroup recently consulted with Health Canada during the development of a manual intended to guide communities across Canada in assessing their food environments. As a result of these consultations, the Health Canada manual and APHEO are recommending the same set of indicators to characterize the community food environment in urban settings.

Despite the strengths of these indicators, there are some limitations. The retail food environment is continuously changing in response to the changing nature of food retail business models. For example, fast-food outlets are increasingly offering healthier choices, while grocery stores continue to introduce many highly processed food choices, which pose challenges to the current "healthy" and "unhealthy" food retail

[i] Statistics Canada defines a dissemination block as "…an area bounded on all sides by roads and/or boundaries of standard geographic areas. The dissemination block is the smallest geographic area for which population and dwelling counts are disseminated. Dissemination blocks cover all the territory of Canada."[41] A dissemination area is a "small area composed of one or more neighbouring dissemination blocks, with a population of 400 to 700 persons."[42]

[ii] We used the following NAICS codes to classify common types of stores and restaurants available within communities: supermarkets and other grocery stores (NAICS 445110); fruit and vegetable markets (NAICS 445230); convenience stores (NAICS 445120); gasoline stations with convenience stores (NAICS 447110); and limited-service eating places (NAICS 722512). This list of outlet types is by no means exhaustive and can be customized according to each public health unit's needs. Examples of alternative lists of outlets may be found in the reference list for this article.[44,45]

classifications. The impact of these changes can in part be ameliorated by ensuring that the consumer (i.e. in-store or in-restaurant) nutrition environment assessments specific to Canadian contexts[55] are included in the evaluation of the local food environment.

Another challenge to measuring the community food environment using the proposed indicators is the reliance on public health inspection databases. While these types of databases are accessible to health unit staff in Ontario and some other provinces (in Quebec and Newfoundland and Labrador such data are collected at the provincial level), it is important to note that they classify retail food outlets based on food safety risk and not for research or monitoring purposes. Therefore, food retail outlets may need to be recategorized (e.g. convenience stores and fruit and vegetable shops are commonly assigned to a single low-risk "food store" category in food inspection databases, but for research purposes should be categorized into distinct outlet types).

Finally, these indicators were developed for use within urban settings. Several studies have proposed different methods for assessing rural environments, citing the unique ways in which rural residents interact with their food environment and the need to consider the dispersed form and unique socio-spatial structure of the rural environment.[56-59]

Conclusion

Given the high prevalence of poor diet quality and excess body weight in Canada, public health agencies are increasingly looking at policies to reshape food environments to better support and promote healthy, active living. A promising means by which local health practitioners can assess their local food environment is through the use of standardized indicators that use readily available data. These assessments can serve as valuable local surveillance data for evaluating the impact of policy interventions. The use of standardized measures that can be applied across Ontario (and Canada) has the added benefit of enabling accurate between-region comparisons of how different policies are reshaping the food environment and impacting health outcomes.

Acknowledgements

The authors would like to acknowledge all the members of the Built Environment Subgroup of the APHEO Core Indicators work group. LMM gratefully acknowledges a Canadian Cancer Society Career Development Award in Prevention Research (grant #704744).

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions

AM and JYP drafted the manuscript, and all authors made revisions and approved the final version of the manuscript.

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https://doi.org/10.24095/hpcdp.37.10.07

At-a-glance

Sentinel surveillance of emergency department presentations for barbecue brush-related injuries: the electronic Canadian Hospitals Injury Reporting and Prevention Program, 2011 to 2017

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Abstract

A barbecue (BBQ) brush is a common household item designed for cleaning grills used for barbecuing. Data from the electronic Canadian Hospitals Injury Reporting and Prevention Program database were analysed to estimate the frequency of injuries related to BBQ brushes as a proportion of all injuries, as well as to describe characteristics associated with such injury events. Between April 1, 2011 and July 17, 2017, BBQ brush injuries were observed at a frequency of 1.5 cases per 100 000 eCHIRPP cases (N = 12). Findings suggest that in addition to risks associated with the ingestion of loose BBQ brush bristles attached to foods, loose bristles could also result in injury via other mechanisms.

Keywords: barbecue brush, grill brush, bristle

Highlights

- The electronic Canadian Hospitals Injury Reporting and Prevention Program (eCHIRPP) database allows for sentinel surveillance of near real-time injury trends and description of injury contexts.
- BBQ brush injuries have been identified in the eCHIRPP at a frequency of 1.5 cases per 100 000 eCHIRPP cases.
- Pediatric and non-pediatric cases had a similar frequency of BBQ brush injury at 1.4 cases and 1.6 cases per 100 000 eCHIRPP cases respectively, though the risk of this injury among these different populations is unknown.
- April and August were the months when injuries occurred most frequently, although injuries occurred through most months of the year.

Introduction

Canadian surgeons are warning people of the potential dangers of loose wire bristles following continued reports of injuries related to the ingestion of wire bristles from a barbecue (BBQ) brush. In one case, a man who struggled with unexplained stomach pains was found to have ingested a BBQ brush bristle, which was ultimately surgically removed from his small intestine.[1] A BBQ brush is a cleaning tool used to remove residue from BBQ grills so as to ensure a clean cooking surface. These bristles, which are often made of steel, may break off or detach from the brush, remain on a BBQ grill, and subsequently transfer to food cooked on the grill without being noticed. In their food safety tips for barbecuing, Health Canada advises people of this potential risk.[2] Studies have reported cases where, once ingested, these thin, sharp wire bristles have perforated or embedded along the aerodigestive and gastrointestinal tract, including at sites such as the tongue,[3] pharynx,[4] small intestine/bowel,[5] and colon.[6]

Recent findings from the United States' National Electronic Injury Surveillance System (NEISS) database have identified 43 cases of wire bristle injury between 2002 and 2014.[7] The objective of this analysis is to identify and describe cases of injuries related to BBQ brushes that were captured within the electronic Canadian Hospitals Injury Reporting and Prevention Program (eCHIRPP) database.

Methods

Data source

The eCHIRPP[8] database is a dynamic web-based injury and poisoning surveillance system that collects patients' accounts of pre-event injury circumstances (narratives of "what went wrong") using an injury reporting questionnaire completed during their visit to the emergency department (ED). Their records are supplemented by clinical information input by an attending physician or other staff, and data coders input additional information to complete the record.[9] This surveillance system better captures less serious cases of injury than traditional injury surveillance databases, such as mortality or hospital administrative data, and also provides details regarding the injury event. Records between

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April 1, 2011 and July 17, 2017 were extracted from the eCHIRPP database for all ages to use for the present analysis.

Key variables

Cases of BBQ brush injury were identified when both of the following criteria were met. The case identification criteria were:

(i) Description of injury

- The direct cause of injury, or main factor for injury, was identified under "Kitchen gadgets and items, not elsewhere classified, including corkscrews, oven mitts, toothpicks, skewers, BBQ brush, etc." (eCHIRPP code 358F), or
- The narrative text included bilingual terms such as "barbeque," "barbecue," "bbq," or "bristle" (or variations thereof).

(ii) Nature of injury

- The nature of injury code indicated a foreign body in the individual's body (code 31 to 37 NI). Existing eCHIRPP codes for patient's age and the external cause, nature, and treatment of injury were used to describe the cases. Pediatric cases (ages 17 years and below) and non-pediatric cases (ages 18 years and above) were examined.

In instances where only one of the two criteria was met, an analyst adjudicated the case manually.

Statistical analyses

Data mining syntax (PERL regular expressions)[10] was used when assessing narrative text. This approach matches relevant character patterns within narrative text with specified search terms so as to identify relevant cases. Descriptive methods were used to present injury frequencies, and logistic regression was used to assess trends over time. Frequency estimates are presented as proportions relative to the total number of records in the database (proportion = (injury N / total eCHIRPP N) *100 000; presented as the number per 100 000 eCHIRPP cases). All analyses were conducted using SAS Enterprise Guide version 5.1 (SAS Institute Inc., Cary, NC, USA).

Results

A total of 12 cases of BBQ brush injuries were identified among 794 237 eCHIRPP records, resulting in a frequency of BBQ brush injury of 1.5 cases/100 000 eCHIRPP cases. No significant changes were observed over time with the number of counts per year staying relatively stable (data not shown). Differences were not observed based on sex, with 6 cases occurring for each.

Figure 1 describes the age groups affected by such injuries, including the frequency of BBQ brush injuries relative to all other eCHIRPP cases. The frequency of BBQ brush injury among pediatric and non-pediatric cases were relatively similar in our dataset at 1.4 cases and 1.6 cases per 100 000 eCHIRPP cases respectively.

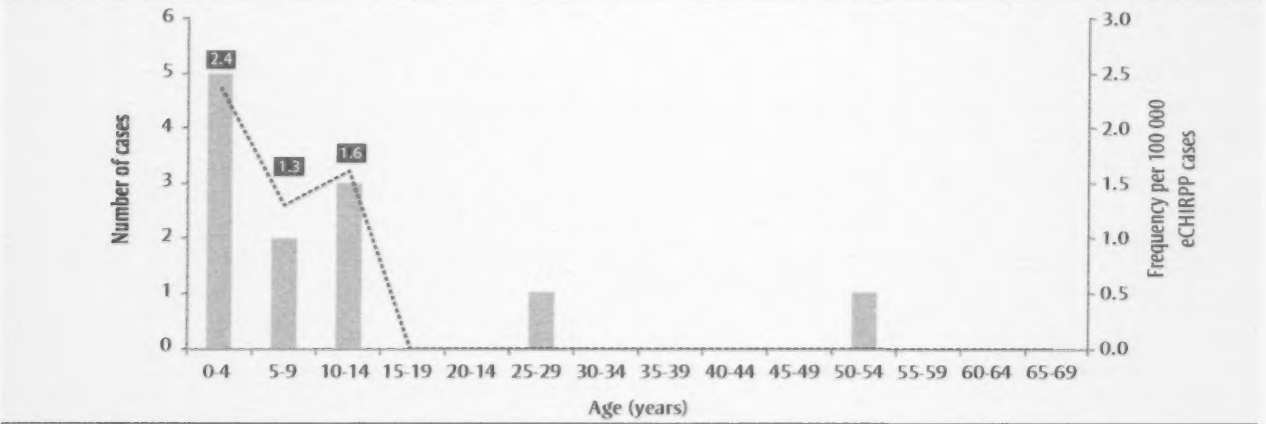
Of all BBQ brush injury cases, only one was identified as occurring external to the home. Cases were observed between April and December, with April and August having the highest proportion (N = 3 and N = 4 respectively). Nine patients reported eating as the mechanism of injury. All but one case was identified to have resulted in an injury to internal organs (pharynx, trachea or esophagus), with the one remaining identified to be to the eye. Finally, five of the observed cases (41.7%) required the patient to be admitted to the hospital as a result of their injury. Table 1 describes the circumstance, nature, and treatment of BBQ brush injury.

Discussion

Although injuries related to BBQ brushes appear to be rare, our findings show that some are severe enough to warrant hospitalization. Due to the small sample size and the higher representation of pediatric hospitals in our database, we cannot make any inferences on the basis of age. However, we do observe that the frequencies of BBQ brush injury as a proportion of all injury cases are relatively equal between pediatric and non-pediatric groups within our study sample. Raw case counts show that April and August were the months with the highest number of BBQ brush injuries, which is similar to reports from the United States where August was also a month with higher counts, although they reported higher numbers of June and July as well.[7]

It is interesting to observe the different circumstances of injury. While the majority

FIGURE 1
Count and frequency of barbecue brush injuries by age group



Data source: Electronic Canadian Hospitals Injury Reporting and Prevention Program (eCHIRPP), April 1, 2011 to July 17, 2017.

Note: Frequency estimates for adults have been suppressed due to random variations on account of the small sample size.

TABLE 1
Key characteristics of barbecue brush injury event

Characteristic of barbecue injury event	Number of cases
Circumstance	
Eating	9
Ingestion of BBQ brush; not further described	2
Contact with eye	1
Nature of injury	
Foreign body in external eye	1
Foreign body in respiratory tract	4
Foreign body in alimentary tract	6
Foreign body in soft tissue	1
Treatment	
Treated in ED with follow-up PRN	5
Treated in ED, follow-up required, referred to other hospital or specialist clinic for injury treatment	2
Admitted to this or another hospital primarily for injury treatment	5

Data source: Electronic Canadian Hospitals Injury Reporting and Prevention Program, April 1, 2011 to July 17, 2017.
Abbreviations: ED, Emergency department; PRN, Pro re nata or if needed.

of cases appear to be linked with a mechanism related to the consumption of barbecued foods, there was a case linked to contact of the foreign body (bristle) with the external eye. Due consideration should thus not only be given to loose bristles becoming attached to BBQ grills and the food cooked upon them, but also more broadly to brushes with loose bristles since they can become detached and airborne.

Strengths and limitations

The eCHIRPP database comprises a selection of EDs across Canada, namely 11 pediatric ones and 7 general sites, so the information presented here should not be used to draw conclusions about BBQ brush injuries across the entire Canadian population. However, previous reports have indicated that CHIRPP data can be representative of the profile of injuries in sports and recreation in Calgary, relative to regional health administration data.[11,12] The benefit of our data source is the ability of this sentinel surveillance system to detect near real-time emerging issues and provide more granular details of injury events that are not available in health administrative data. Certain groups are under-represented in the eCHIRPP data, such as older teens, Aboriginal persons, people who live in rural areas, and fatal cases. While information bias was minimized by the use of standardized injury-reporting questionnaires, our estimates of BBQ brush injury are likely an underestimate since cases were identified based on key search terms that were explicitly used in the narrative text or based on the use of the appropriate direct cause code. Other cases of BBQ brush injury may have been misclassified if these conditions were not met, or may not have been detected if the patient was not aware that a BBQ brush was involved in their injury at the time that they filled in the injury reporting questionnaire. Finally, since our frequency estimates are based on the proportion of BBQ brush injuries among all eCHIRPP injuries, this study cannot provide estimates of overall risk.

Conclusion

BBQ brush injuries, though rare in Canada, can result in serious injury. Health Canada collects information on consumer product issues, including injuries related to BBQ brushes, through an incident reporting system. Medical professionals and consumers are encouraged to submit details of consumer products incidents to https://www.canada.ca/en/health-canada/services/consumer-product-safety/advisories-warnings-recalls/report-incident-involving-consumer-product.html. Our finding that BBQ brush injuries were not isolated to cases involving the consumption of foods cooked on a BBQ suggests that injury prevention and awareness efforts should highlight the risks associated with loose BBQ brush bristles across a variety of potential circumstances of injury.

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